VOL. XIV, JULY 4, 1885.

ENGINEERING NEWS

AND

AMERICAN CONTRACT JOURNAL.

Record of Tests of Cement Made for Boston Main Drainage Works, 1878-1884.*

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The construction of a system of intercepting and outfall sewers for the city of Boston, Mass., was begun in the fall of 1877. The works required to complete the system included about 17 miles of large sewers, a pumping station and a reservoir. The principal materials entering into these structures were brick, stone and concrete masonry. About 180,000 barrels of cement were required to build this masonry, and to insure its stability and durability it was necessary that the cement should be of good quality. From the start, therefore, means for determining the qualities of all cements used or offered for use were provided. A room was set apart for these operations and an inspector appointed to conduct them.

The tests were devised, principally, in order to determine three points, namely:

1. The relative strength and value of any cement as compared with the average strength and value of the best quality of similar kinds of cements.

2. The absolute and comparative strength and value of mortars of different kinds made from the same cement.

3. The effect produced upon the strength of any cement mortar by different conditions and methods of treatment.

This knowledge was chiefly sought by observations of the tensile strength of the cements and mortars tested. Reasons for adopting the tensile test were that it required comparatively light strains to produce rupture; that, as it was universally used, it afforded results which could be compared with those of other observers, and, finally, because the tensile stress is precisely that by which the mortar of masonry, in most cases of failure, actually is broken.

All the particles of any cement are of appreciable size, and its strength as a mortar depends on the extent to which the particles adhere, at their points of contact, to each other or to some inert substance. This adherence may be overcome and the mortar broken, either by pulling the particles apart by tension or by pushing them past each other by compression. The effect upon the adhering quality of the particles is not very different in the two operations, but in the latter the friction of the particles against each other must also be overcome, which requires the application of very much more force. Transverse tests are only tensile tests differently applied, and shearing produces a stress intermediate to tension and compression. When masonry is strained, one part of it is in tension another in compression, and, as mortar yields more readily to tensile stress, failure generally occurs by rupture of the joints in tension.

Briquettes for testing, with a breaking section of one square inch, were first used, but it was thought that these, from their small size, were liable to be strained and injured by handling in taking them from the moulds and transferring them to the water. A larger pattern with a breaking section one and one-half inches square or two and one-quarter square inches was finally adopted. Comparative tests with briquettes of one inch and two and one-quarter inches section respectively indicated that there was little, if any, difference in their strength per square inch.

The shape of the briquette adopted is shown by Fig. 2, Plate II. Fig. 1 of the same plate shows the brass moulds in which the mortar was packed to form the briquettes. These moulds proved very satisfactory. They were strong, and easily clamped and opened. The clamp consisted of a piece of brass wire riveted loose in the projecting lug of one branch of the mould, and binding by friction when turned against the wedge-shaped lug on the other branch. If a fastening worked loose, a single tap of the hammer would tighten it. All breaking loads were reduced to pounds per square inch of breaking section by multiplying by four and dividing by nine.

Before testing a cement its color was first observed. The absolute color of a natural cement indicates little, since it varies so much in this particular. But for any given kind, variations in shade may indicate differences in the character of the rock or in the degree of burning. With Rosendale cements a light color generally indicated an inferior or underburned rock. An undue proportion of underburned material was indicated in the case of Portland cement by a yellowish shade, and a marked difference between the color of the hard-burned, unground particles retained by a fine sieve and the finer cement which passed through the sieve.

The weight per cubic foot was also sometimes ascertained. As this would vary with the density of packing, a standard for comparison was adopted, which was the density with which the cement would pack itself by an average free fall of three feet. The apparatus used is shown by Fig. 3, Plate II. The cement was placed in a coarse sieve on the top of a galvanized iron tube, and, the sieve being shaken, the cement sifted through the tube into the box below. This box held exactly one-tenth of a cubic foot when struck level with its top.

The weights per cubic foot as determined by this method varied considerably with different kinds and brands of cement, and somewhat with different samples of the same brand. The averages were as follows:

TABLE No. 1.

Rosendale	49	to 56	pounds.
Lime of Teil		50	"
Roman		54	"
A fine-ground French Portland		69	"
English and German Portlands	77.5	to 87	"
An American Portland		95	"

The following table shows the effect of fine grinding upon the weight of cement. It gives the weight per cubic foot of the same German Portland cement containing different percentages of coarse particles as determined by sifting through the No. 120 sieve.

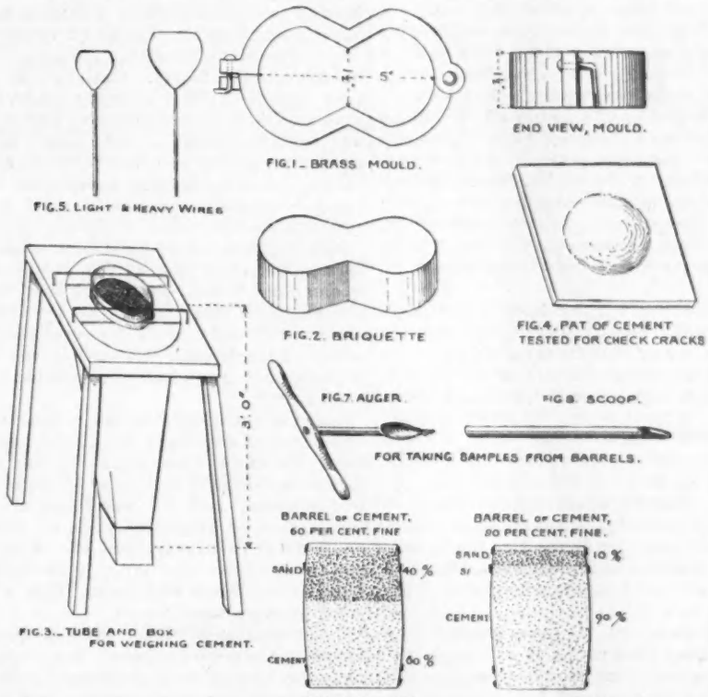

PLATE II.

*Reprinted from Transactions of the American Society of Civil Engineers, April, 1885. Paper presented April 15.

TABLE No. 2.

0 %	retained by No.	120	sieve—W't per cu. ft.	75	pounds
10 %	"	"	"	79	"
20 %	"	"	"	82	"
30 %	"	"	"	86	"
40 %	"	"	"	90	"

It was soon discovered that there was no direct ratio between weight and strength. As a general rule, subject to exceptions, heavy cement, if thoroughly burned and fine-ground, was preferred to light cement. Fine-ground cements were lighter than coarse-ground, and under-burned rock lighter than well burned. While color and weight by themselves indicated little, yet considered together and also in connection with fineness, they enabled the inspector to guess at the character of a cement and suggested reasons for high or low breaking. A cement which was light in color and weight, and also coarse-ground, would be viewed with suspicion.

The test of fineness, which followed, was considered of great importance, as showing the quantity of actual cement contained in a barrel, and its consequent value. Small scales were used, made for this purpose by Fairbanks & Co. One-quarter of a pound of the sample was weighed out and passed through the sieve. The coarse particles retained by the sieve were returned to the scales, whose balance beam carried a movable weight and was graduated in percentages of one-quarter pound. The percentage of coarse particles retained by the sieve could thus be read directly from the beam.

Standard sieves, varying from No. 50 to No. 120, were used. The number of meshes to the lineal inch in any sieve is commonly supposed to correspond with its trade number. As sold, however, they vary somewhat, and the number of wires is generally less, by about ten per cent., than the number of the sieve. A No. 50 sieve commonly has about 45 meshes to the inch and a No. 120 about 100, or a few more. In important contracts, where a certain degree of fineness was called for, it was customary carefully to compare two sieves and retain one, which was specified as the standard, while the other was delivered to the manufacturer for his guidance.

In accordance with common practice, the No. 50 sieve was first used. It was soon discovered, however, that so coarse a sieve did not always give a correct indication of the fineness of the cement. This was especially true of Portland cements. Some brands, chiefly German, was evidently bolted by the manufacturers with special reference to tests by this sieve, in which they would leave no residuum. Yet the bulk of such cements, while containing no very coarse particles, might prove quite coarse when tested by the number 120 sieve.

It is obvious that pieces of burned cement slag ¼ of an inch in diameter would have no cementing quality, and the same is true of particles $\frac{1}{100}$ of an inch in diameter. At precisely what smaller size the particles begin to act as cement it was impossible to determine. Those retained by a No. 120 sieve in which the open meshes are approximately $\frac{1}{100}$ of an inch square, were found to have some slight coherence, even after washing to remove the finer floury cement which was sticking to them. It was also found that the No. 120 sieve was about as fine a one as it was practicable to use, on account of the time required to sift the cement through it. It was, therefore, adopted as a standard.

Assuming (what was only approximately verified by experiments on tensile strength) that only what passed through this sieve had real value as cement, and that the rest was not very different from good sharp sand, the difference in the quantity of actual cement obtained in purchasing barrels 60 and 90 per cent. fine, respectively, is shown by Figs. 9 and 10, Plate II. This has an important bearing on the proportion of sand to be added in practical use; for when water is mixed for use in the proportion of one barrel of cement to two of sand, if there be nine parts of cement and one of sand in the barrel of cement itself, the actual proportion in the mortar will be .9 to 2.1 or 1 to 2.33. If there be only six parts of cement and four of sand in the barrel of cement, the resulting proportion in the mixture will be .6 to 2.4 or 1 to 4.

Fine cement can be produced by the manufacturers in three ways: by supplying the mill-stones with comparatively soft, underburnt rock, which is easily reduced to powder; by running the stones more slowly, so that the rock remains longer between them; or by bolting through a sieve and returning the unground particles to the stones. The first process produces an inferior quality of cement, while the second and third add to the cost of manufacturing.

The extra cost, as estimated by a firm of English manufacturers, of reducing a Portland cement from an average of 70 per cent. fine, tested by No. 120 sieve, to 90 per cent. fine, was 18 cents per barrel. The price at which 5,000 barrels of their ordinary make, 70 per cent. fine, were offered, delivered on our work, was $2.82 per barrel. The same cement, ground 88 per cent. fine, was delivered for $3 a barrel. On the foregoing assumption of the value of fine and coarse particles, the city, by accepting the first offer, would have obtained in bulk 3,500 barrels of actual cement and 1,500 barrels of sand for $14,100. By accepting the second offer, it obtained in bulk 4,400 barrels of cement and 600 of sand for $15,000. That is, the 900 additional barrels of cement cost $1 a barrel. Experiments illustrating the value of fine grinding and further comments will be given later.

Tests were made both of neat cement and of cement mixed with sand in different proportions. The latter were preferred because they showed the strength and value of the mortars used in actual work. It was found also that the strength of briquettes made of neat cements did not always indicate the capacity of these cements to bind sand, or the strength of the mortars made with them. This is illustrated by experiment No. 10.

The greater the portion of sand, in the mortar tested, the more accurately was the actual cementing quality of the cement indicated.

As, however, very weak mixtures took a long time to harden, and were liable to injury from handling, one part cement to three parts sand was adopted as the usual mixture for testing Portland cements, and one to one and one-half or two for American cements. Occasionally, when testing large quantities of some well-known brand, the object being to see that a uniform strength was maintained, it was found sufficient, and simpler, to omit the sand and make the briquettes of cement only.

In making mortars for testing, rather coarse clean, sea-beach sand was used.

The subsequent strength of the briquettes depended largely upon the amount of water with which they were gauged. The highest results were obtained by using just enough water thoroughly to dampen the cement, giving the mass the consistency of fresh loam, which became pasty by working with a trowel. For ordinary testing, sufficient water was added to make a plastic mortar somewhat stiffer than is commonly used by masons. Different cements varied in the amounts of water needed to produce this result. As a rule American cements needed more water than Portland, fine-ground more than coarse, and quick-setting more than slow-setting cements. Experiment No. 9, shows the comparative strength of mortars gauged with different percentages, (in weight of the cement), of water. The standard adopted was 25 per cent. for Portland cement and 33 per cent. for Rosendale, but these amounts were increased or diminished by the operator to suit the circumstances, his aim being to obtain mortars of unvarying consistency.

The way in which the test briquettes were made was as follows: The moulds, having been slightly greased inside to prevent the mortar sticking to them, were placed on a polished marble slab. This support for them was used because it was easily cleaned and the mortar did not stick to it. Experiment No. 6, shows that the use of porous or of nonporous beds to support the moulds does not materially affect the strength of the mortars. The requisite amounts of cement and sand for one briquette were weighed out and incorporated dry in a mixing-pan. The proper amount of water was also weighed out and added, and the mass worked briskly with a small trowel until of uniform consistency. A brass mould was half filled with the mortar, which was rammed into place by the operator with a small wooden rammer, in order to displace any bubbles of air which might be confined in it. The mould was then filled to its top with the remaining mortar, which was in turn rammed down. Finally the mortar was struck even with the top of the mould and given a smooth surface by the trowel.

The amount of mortar packed in the mould and the consequent density of the briquette would vary with any variation in the degree of force exerted by the operator in ramming. This variation was reduced to a minimum by always mixing a fixed amount of mortar, which was barely more than sufficient to fill one mould. Irregularities in ramming would thus be detected by variations in the amount of surplus mortar, and could be checked. An attempt was made to do away wholly with this element of uncertainty by pressing the mortar into the moulds with certain fixed pressures. Apparatus was devised and used for this purpose, but was finally abandoned on account of the length of time required for its use.

The initial energy of the cement—that is, the length of time after mixing before it "set" was determined by noting the length of time before it would bear "the light wire" of $\frac{1}{12}$ inch in diameter loaded with ¼ pound weight, and also "the heavy wire" $\frac{1}{24}$ inch in diameter loaded with 1 pound weight. At the former time, the cement was said to have begun to set; and at the latter, it was entirely set. Different kinds and brands of cement varied greatly in the time after mixing when they would bear the wires. Some brands of English Roman cement would set in two minutes; and some of Portland required over 12 hours. Cold retarded the setting; and fresh-ground cements set quicker than older ones. No direct relation was established between initial energy and subsequent strength. By judicious mixing of quick and slow setting cements, a mixture could be obtained which would set within any desired period.

As soon as the briquettes were hard enough to handle without injury, which with different cements and mixtures varied from 5 minutes to 12 or more hours, they were removed from the moulds and placed in numbered pans filled with water. Before removal each briquette had marked upon it, with steel stamps, the name of the cement, date of mixing, and a number by which it could be further identified. The inscription might read thus:

"Alsen 1-3. May 17, 1880. 47."

Records were also kept in books and on blanks provided for the purpose. The briquettes were kept in the pans, covered with water, until they were broken. Their age when broken varied from 24 hours to 5 years.

In testing a well-known American cement, of generally uniform quality, if it were an object to save time, the comparative excellence of the samples could be sufficiently determined by a 24-hours test of briquettes made of neat cement. Under similar conditions neat Portland cement could be tested in 7 days. To test mortar of either kind of ce-

ment took a week—or, better, a month—especially if there was a liberal proportion of sand.

The probable value of an untried brand of cement could hardly be ascertained with certainty in less than a month, and not always then. To illustrate the occasional need of long-time tests, a case may be cited.

A new brand of cement, made by some patent process, was offered for use on the work. When tested it set up well, and at the end of a week the neat cement had a tensile strength of 184 pounds per square inch. In a month this had increased to 267 pounds, indicating a strength equal to that of a low-grade Portland cement. At this time there was nothing in the appearance of the briquettes to indicate any weakness. Yet after about 6 months they fell to pieces, and had entirely lost their cohesive quality.

The briquettes were broken by a machine made for the Department by Fairbanks & Co. It worked with levers, acting on a spring balance, which was tested from time to time, and found to maintain its accuracy.

During the progress of the work the following brands of cement were submitted for approval, and were tested with more or less thoroughness:

Old Newark, Newark and Rosendale, Norton, Hoffman, Old Rosendale, New York and Rosendale, Lawrenceville, Rosendale, Arrow, Keator, Howe's Cave, Rock Lock, Buffalo, Cumberland, Round Top, Selenitic, Vorwohler, Star, Dyckerhoff, Alsen, Hemmor, Bonnar, Onward, Burham, J. B. White, Knight, Bevan & Sturge, Brooks, Shoobridge & Co., Leavitt, Grand Float, Diamond, Spanish, Red Cross, La Farge, Lime of Teil, Saylor, Coolidge, Walkill, Cobb, Abbott.

The following is a record of the more instructive tests made for experimental purposes. Nearly all of them were made with special reference to the work then in hand, to elucidate some practical questions affecting the purchase, testing or use of the cements needed for building purposes. The names of the brands of cement tested in the several experiments are generally omitted. This is in order to avoid any unwarranted use of the results as recorded.

The figures given in the tables always represent average breaking loads in pounds per square inch of breaking section.

EXPERIMENT NO. 1.

Of natural American cements, the Rosendale brands (so-called) are the only ones which find a sale in the Boston market, and they were chiefly used on the wo r Imported Portland cements were also largely used. It was important, therefore, to ascertain the actual and comparative strengths of these cements. The following table gives results compiled from about 25,000 breakings of twenty different brands, and fairly represents the average strength of ordinary good cements of the two kinds. Some caution, however is necessary in using the table as a standard with which to compare other cements. Quick-setting cements might be stronger in a day or week, and show less increase in strength with time. Fine-ground cements would probably give lower results tested neat, and higher ones with liberal proportions of sand.

The table is instructive in several ways. It shows that Portland cement acquires its strength more quickly than Rosendale; that both cements (but especially Rosendale) harden more and more slowly, as the proportion of sand mixed with them is increased; that whereas neat cements and rich mortars attain nearly their ultimate strength in si. months or less, weak mortars continue to harden for a year or more. The table shows the advantage of waiting as long as possible before loading masonry structures, and the possibility of saving cost by using less cement when it can have

TABLE NO. 3.

Neat Cement.					Cement, 1. Sand, 1.				Cement, 1; Sand, 1.5.				Cement, 1; Sand, 2.				Cement, 1; Sand, 3.				Cement, 1; Sand, 5.			
1 Day.	1 Wk.	1 Mo.	6 Mos.	12 Mos.	1 Wk.	1 Mo.	6 Mos.	12 Mos.	1 W	1 Mo.	6 Mos.	12 Mos.	1 Wk.	1 Mo.	6 Mos.	12 Mos.	1 Wk.	1 Mo.	6 Mos.	12 Mos.	1 Wk.	1 Mo.	6 Mos.	12 Mos.
ROSENDALE CEMENT.																								
71	92	145	282		290	56	116	190	256	41	95	155	230	24	60	125	180	14	35	80	121	5	16	46	80
PORTLAND CEMENT.																								
102	303	412	468		494	160	225	347	387	..	..	..	..	126	163	279	323	95	140	198	257	55	88	136	155

TABLE NO. 4.

Age when Broken.	Neat Cement.	Cement 1, Sand 2.	Cement 1, Sand 4.	Cement 1, Sand 6.	Cement 1, Sand 8.	Cement 1, Sand 10.	Cement 1, Sand 12.
PORTLAND CEMENT MORTAR.							
One week	295	166	89	50	33	23	17
One month	341	243	132	88	67	50	41
Six months	374	343	213	149	98	76	51
Two years	472	389	226	159	98	69	31
ROSENDALE CEMENT MORTAR.							
One week		24	7	5			
One month		84	32	17	8	5	
Six months		172	93	62	50	33	21
Two years		211	90	56	33	22	20

ample time to harden. It also shows that Portland cement is especially useful when heavy strains must be withstood within a week.

EXPERIMENT NO. 2.

These series of tests are like the preceding ones, except that a single brand of cement was used in making each. The average breaking loads per square inch were obtained from a less number of briquettes (about 500 in all,) mortars with large proportions of sand were included in the series, and the tests were extended for two years.

The tables show that considerable strength is acquired in time, even when a very large proportion of sand is used; also, that most mortars increase very little, if any, in tensile strength after six months or a year. They become harder with time, but also become more brittle and probably less tough. Specimens of mortar two years old or more, break very irregularly.

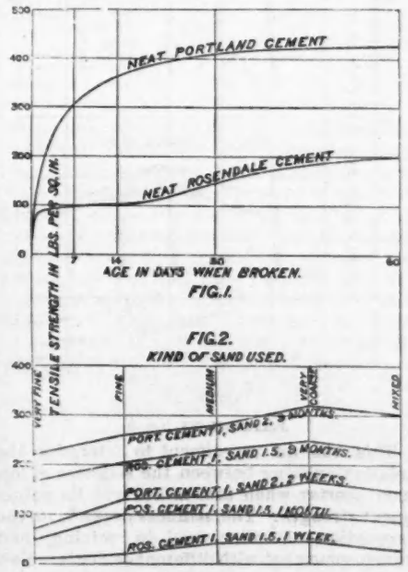

PLATE III.

EXPERIMENT NO. 3.

The rate at which Rosendale and Portland cements, respectively, increase in strength during the first two months after mixing is very different, and has some bearing on their use, and more on the interpretation of tests of them made within that period. The curves, Fig. 1, Plate III, which indicate this rate of increase, were compiled from tests with neat cement. It is probable that tests with mortar would give somewhat similar results. By comparing the two curves, it appears that after 24 hours Rosendale cement has about ¼ of the strength of Portland. While the latter increases greatly in hardness during the next few days, the energy of the former becomes dormant, so that at the end of a week the Portland cement is more than three times as strong as the Rosendale. During the second week the Portland cement increases more slowly, and the Rosendale continues nearly quiescent. At about this period, and for the next six weeks, the Rosendale cement gains strength, not only relatively, but actually faster than the Portland, so that when 2 months old the former has ½ the strength of the latter. After 2 months the relative rate of increase and the comparative strength of the two cements remain nearly unchanged. A series of tests with a Buffalo cement, and one with a Cumberland cement, gave results similar to those with Rosendale cement.

EXPERIMENT NO. 4.

For making tests it is not always convenient to obtain sand of uniform size, and still less so to obtain such sand in sufficient quantities for use in work. The curves, Fig. 2, Plate III, record some tests made to determine the effect of fineness and of uniformity of size in sand upon the strength of mortars made with it.

The curves show that for comparative tests it is advisable to have sifted sand of nearly uniform size; that mortars made with coarse sand are the strongest, and that the finer the sand the less the strength. It also appears that mixed sand, *i. e.*, unsifted sand containing a mixture of particles, from coarse to fine, makes nearly as strong a mortar as coarse or medium coarse sand. For use in work, therefore, it is well to avoid fine sands, but it is not necessary to have sand of uniform size, or to sift out a moderate proportion of fine particles.

EXPERIMENT NO. 5.

As some experimenters on cement use a test briquette with a breaking section of 1 square inch, and others one with a section of 2½ square inches, the following experiment was made to determine the difference, if any, in the strength acquired by the same mortars moulded into briquettes of these different sizes. Two series of tests were made, in the same way, with the same mortars. In one series the briquettes had a breaking section of 1 square inch, and in the other the section was 2½ square inches. The results are given in Table No. 5, in which the figures represent breaking loads in pounds per square inch, and are averages from 5 breakings.

As is usual, the breaking loads are somewhat irregular, the inch section excelling at at some points, and the larger sections at others. The experiment, however, seems to indicate that neither side will, as a rule, give higher results than the other.

EXPERIMENT NO. 6.

Some experimenters have thought it important to place the moulds in which mortar is

TABLE No. 5.

	Rosendale Cement.						Portland Cement.					
	Neat Cement				Cement 1 Sand 1. 5.			Neat Cement.			Cement 1,Sand 1 5,	
	1 Day.	1 Week.	1 Month.	6 Months	1 Week.	1 Month.	6 Months	1 Week.	1 Month	6 Months	1 Week.	1 Month	6 Months
1-inch Section	49	73	156	286	27	53	236	309	460	657	60	96	175
2½-inch Section	49	78	173	258	27	62	311	347	391	578	67	108	230

packed for testing upon a porous bed, such as blotting paper or plaster. Others use a non-porous bed of glass, slate or marble. The following series of tests were made to discover the effect of these different modes of treatment. The figures in the tables represent breaking loads, in pounds per square inch, and are averages of about ten breakings.

TABLE No. 6.

ROSENDALE CEMENT.

Mixture.	Kind of Bed.	One Week.	One Month.	Six Months.	One Year.
Neat	Marble....	95	151	288	325
	Plaster....	106	178	303	316
Cement, 1 Sand, 1, 5	Marble....	44	107	210	251
	Plaster....	62	120	219	265

A CUMBERLAND CEMENT.

Mixture	Kind of Bed.	One Day.	One Week.	One Month.	Six Months	One Year.
Neat.	Marble..	128	133	142	231	241
	Plaster..	147	165	176	244	257
Cement, 1, Sand, 1, 5.	Marble..	.....	107	161	275	339
	Plaster..	.....	128	166	299	345
Cement, 1, Sand, 1, 2.	Marble..	.....	85	134	201	292
	Plaster..	.....	111	148	241	294
Cement, 1, Sand, 1, 4,	Marble..	.....	40	94	162	163
	Plaster..	.....	46	91	164	170

GERMAN PORTLAND CEMENT.

Mixture.	Kind of Bed.	One Week.	One Month.	Six Months	One Year.
Cement, 1, Sand, 1,	Marble.....	259	367	390	.....
	Plaster.....	213	376	411	.....
Cement, 1, Sand, 2,	Marble.....	176	256	346	345
	Plaster.....	196	258	326	357
Cement, 1, Sand, 3,	Marble.....	141	225	250	313
	Plaster.....	147	220	258	312
Cement, 1, Sand, 4,	Marble.....	103	157	240	274
	Plaster.....	120	150	233	264
Cement, 1, Sand, 5,	Marble.....	82	103	182	213
	Plaster.....	103	140	193	197

Making allowance for a few irregularities, it appears from the foregoing tables that the use of a porous bed gives slightly higher results for the first one or two months, but that the difference disappears or becomes insignificant with age.

Experiment No. 7.

It is a well-recognized fact that in experimenting with cements, even when great care is exercised, individual specimens break very irregularly, and that results even approximately conforming to theory can only be obtained from averages from a large number of breakings. The personal equation of the operator and the degree of force with which he presses the mortar into the moulds is one factor in producing irregular results. To do away with this, a machine for packing the moulds was desired and used for a time. By this the mortar was pressed into the moulds by a metallic plunger, acting with definite pressures varying from 50 to 400 pounds.

The machine-made briquettes broke with somewhat greater uniformity than hand-made ones. So much more time was required to make briquettes with this machine that it was found to be impracticable to employ it for general use.

Experiment No. 8.

By the sea it is frequently convenient to mix mortar with salt water. Brine is also used in winter as a precaution against frost. This experiment was made to obtain the comparative effect of mixing with and immersing in fresh and sea water respectively. The tests were made upon a Rosendale mortar, mixed one part cement to one part sand, and an English Portland mortar, one part cement to two parts sand. The figures are averages of about ten breakings, and give the tensile strength in pounds per square inch with different methods of treatment and at different ages.

TABLE No. 7.

Rosendale Cement Mortar 1 to 1.					Portland Cement Mortar, 1 to 2.			
Fresh Water.	Fresh	Salt	Salt	Mixed with	Fresh	Fresh	Salt	Salt
Fresh Water.	Salt	Fresh	Salt	Immersed in	Fresh	Salt	Fresh	Salt
40	48	50	61	One week.	151	122	152	149
126	135	114	126	One month.	213	191	203	200
247	250	243	224	Six months.	314	245	277	264
310	263	224	217	One year.	342	231	346	295

Except for some irregularity in the breakings for one year (which may have been due to the manipulation), the table indicates that salt, either in the water used for mixing or that of immersion, has no important effect upon the strength of cement. Salt water retards the first set of cement somewhat.

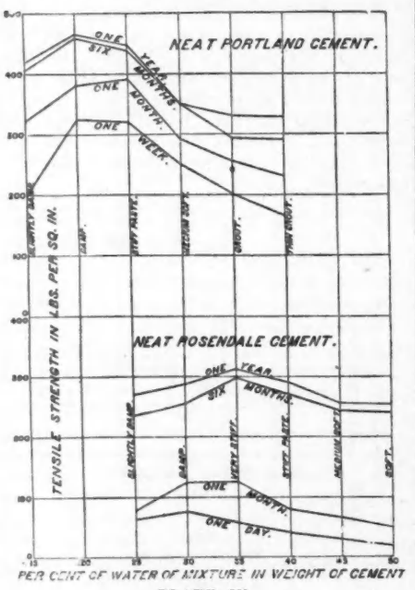

PLATE IV.

Experiment No. 9.

This was an experiment to determine the relation existing between the stiffness of cement mortar when first mixed and its subsequent strength. The stiffness depends on the proportion of water used in mixing, and varies somewhat with different cements. Natural American cements take up more water than Portland cements, and fine ground more than coarse cements. Many series of tests bearing on this point were made. The results obtained from two of the more complete series are shown by the curves on Plate IV. The cements used in these tests were a rather coarse English Portland and a fair Rosendale. Each of the points in the curves represents an average from about ten briquettes. The cements were tested neat, and the amounts of water used were different percentages, by weight, of the amounts of cement. The resulting stiffness of mortar is indicated on the curves. This varied from the consistency of fresh loam to a fluid grout. The time of setting is greatly retarded by the addition of water.

The curves show that from 20 to 25 per cent. of water gives the best results with Portland cement, and from 30 to 35 per cent. with Rosendale; that the differences in strength due to the amount of water are considerable at first, but diminish greatly with age; that the soft mortars, even when semi-fluid like grout, attain considerable strength in time.

Experiment No. 10.

From the first it was observed that fine ground cements were less strong when tested neat, and stronger when mixed with sand, than were coarse cements. A few examples of this are given below. In the first table a coarse English Portland cement is compared with a fine ground French Portland. The per cent. of each retained by the fine No. 120 sieve is given, and the tensile strength, in pounds per square inch at the end of 7 days.

TABLE No. 8

Kind of Cement.	Per cent. retained by No. 120 Sieve.	Parts of sand to 1 part of Cement				
		0	2	3	4	5
English Portland	37	319	125	89	59	43
French Portland	13	318	205	130	114	86

Such examples could be multiplied. German Portland cements were commonly finer ground than English and, as a rule, were no stronger, or less strong, tested neat, but were much stronger with liberal proportions of sand. In the following table two lots of the same brand of English Portland cement are compared. The coarse cement was the ordinary make of the manufacturers; the fine cement differs in no particular from the other except that it was ground more slowly and finer, to meet the requirements of a special agreement. The age of the samples when broken was 28 days.

TABLE No. 9.

Kind of Cement.	Per cent. retained by No. 120 Sieve	Parts of Sand to 1 part of Cement.		
		0	3	5
Ordinary Cement	35	403	105	68
Fine-ground Cement.	12	304	180	96

Different brands of Rosendale cement varied considerably in their fineness. Those of the best reputation would leave from 4 to 10 per cent. residuum in the No. 50 sieve; other brands would leave in the same sieve from 10 to 23 per cent. In the following table is compared the average tensile stength obtained from experiments with three of the finer ground brands, and also with three other brands of good reputation, but more coarsely ground. The age of the specimens was one week.

TABLE No. 10

Kind of Cement.	Percent. retained by No. 50 Sieve.	Parts of sand to 1 part Cement.		
		0	1.5	2
Fine Rosendale	6	92	41	25
Coarse Rosendale	17	98	29	16

The foregoing experiments show that it is impossible, by tests on the tensile strength of neat cements alone, to judge of their value in making mortar for practical use; also that fine-ground cements make stronger mortars than do coarser ones.

A number of series of tests were made of cements which had been sifted through sieves of different degrees of fineness, and had thereby had different percentages of coarse particles removed from them. The results from

these experiments were quite uniform and showed that, in proportion as its coarse particles were removed, a cement became more efficient for making mortars with sand.

Table No. 11, gives the results obtained from one such series of tests made with an English Portland cement. In the experiment comparison is made between the strength of mortars made with the ordinary cement, unsifted as it came from the barrel, and those made with the same cement after having been sifted through Nos. 50, 70, 100 and 120 sieves, which, respectively, eliminated more and more of the coarse particles. The per cent. of particles which would still be retained by the fine No. 120 sieve, after sifting through the coarser sieves, is given in the second column of the table. There is included in the table an extra coarse cement, which was made so by adding to unsifted cement a certain amount of the coarse particles taken from the sifted cements. The tensile strength is given in pounds per square inch.

In a similar series of tests with Rosendale cement mortars the increase in strength obtained by substituting fine for coarse particles in the cement was much less marked. The coarse particles were softer than those from Portland cement and had, in themselves, some power of cohesion. As previous tests had shown that fine-ground Rosendale cements were stronger, with sand, than coarse-ground, it was assumed that the superiority was due, not so much to the absence of palpably coarse particles as to the fact that the bulk of the cement was more floury and thus better adapted to coating and binding the particles of sand. Probably natural American cement is as much improved as is Portland cement by fine grinding, but in the case of the former there would not be the same relative advantage in bolting out the coarse particles after grinding.

The following series of tests may be of interest on account of the age of the specimens. The mortars were made with an English Portland cement, both unsifted as taken from the cask, and also after it had been sifted through the No. 120 sieve, by which process about 35 per cent. of coarse particles were eliminated.

Table No. 12 also shows that fine cements do not give as high results tested neat as do cements containing coarse particles, even coarse particles of sand. It also shows (what is often noticed) that neat cements become brittle with age, and are apt to fly into pieces under comparatively light loads.

The series of tests which follows was made for the purpose of ascertaining what value, if any, for cementing purposes, were possessed by the hard, coarse particles of Portland cement. Mortars were made with an ordinary English Portland cement, and compared with similar mortars made with the same cement, after sifting through No. 120 sieve, which retained 33 per cent. of coarse particles.

As usual, the coarse cement was stronger neat, and weaker with sand. Assuming that the 33 per cent. of coarse particles retained by the sieve had *no* value as cement, acting merely as so much sand, and assuming also that all which passed through the sieve was good cement, it follows that the ordinary unsifted cement with two parts of sand made a mortar in which the proportion of real cement to sand was .67 to 2.33, or about 1 to 3.5. Hence, the mortar made with fine cement and three parts of sand should be as strong, or a little stronger, than that made with the coarse cement and two parts of sand. It will be seen that the results in Table No. 13 sustain the assumption very well.

If, then, the coarse particles are assumed to act merely as so much sand, it will not lessen the efficiency of the cement to remove its coarse particles, and to substitute actual sand in their place. This was done in making the following series of tests. One set of briquettes was made with ordinary cement, and another set with the same cement from which 33 per cent. of coarse particles had been removed and replaced with fine sand.

TABLE No. 11.

KIND OF CEMENT USED IN MAKING MORTARS.	PER. CENT. OF PARTICLES RETAINED BY No. 120 SIEVE.	ONE WEEK.				ONE MONTH.				SIX MONTHS.				ONE YEAR.			
		Parts of Sand to 1 part of Cement.															
		2	3	4	5	2	3	4	5	2	3	4	5	2	3	4	5
Cement with coarse particles added	55	72	59	32	19	117	80	67	40	210	135	122	84	200	128	112	92
Ordinary Cement, unsifted	33	129	92	58	43	197	143	109	88	311	236	183	136	286	247	168	163
Cement which passed No. 50 Sieve	28	159	97	67	47	210	138	125	102	323	246	190	146	328	240	214	178
Cement which passed No 70 Sieve	18	163	117	82	65	239	168	151	112	338	256	225	173	342	295	230	193
Cement which passed No. 100 Sieve	8	177	123	84	73	255	185	156	122	257	288	239	182	382	307	257	215
Cement which passed No. 120 Sieve	0	198	154	95	86	271	200	161	132	379	320	238	196	386	316	262	218

TABLE No 12.

KIND OF CEMENT.	NEAT CEMENT.		CEMENT, 1; SAND, 2.		CEMENT, 1; SAND, 5.	
	2 Years.	4 Years.	2 Years.	4Years.	2 Years.	4 Years.
Ordinary Cement, unsifted	603	387	339	493	182	202
Cement which passed No. 120 sieve	374	211	478	580	250	284

TABLE No. 13.

KIND OF CEMENT.	ONE WEEK.			ONE MONTH.			SIX MONTHS.			ONE YEAR.		
	Parts of Sand to one part of Cement.											
	0	2	3	0	2	3	0	2	3	0	2	3
Ordinary Cement, unsifted	353	139	86	279	201	142	438	323	253	444	343	271
Cement which passed No. 120 Sieve	311	187	132	243	275	201	268	367	310	306	434	333

TABLE No. 14.

KIND OF CEMENT.	ONE WEEK.		ONE MONTH.		SIX MONTHS.		ONE YEAR.	
	Parts of Sand to one part of Cement.							
	2	3	2	3	2	3	2	3
Ordinary Cement unsifted	139	86	201	142	324	253	313	271
Cement with 33% coarse particles removed and fine sand substituted	101	67	160	100	253	206	305	240

These briquettes refused to break in accordance with the theory, and the assumed hypothesis was not verified. It is evident that, for making mortar, the coarse particles of Portland cement are superior to ordinary sand, but much inferior to fine cement. In the mortars made with the cement in which the coarse particles had been replaced with fine sand, the real proportions of cement to sand were 1 to 3.5 and 1 to 5. It will be noticed that the tensile strength was not reduced in like proportion.

EXPERIMENT No. 11.

While building masonry laid in American cement mortar, it is sometimes desirable to increase the strength of the mortar temporarily or in places. Rich Portland cement mortars are expensive, and those with large proportions of sand are too porous for many purposes. The desired strength can be gained by using, instead of the simple American cement, the same cement mixed with a percentage of strong Portland cement.

The following series of tests was designed to ascertain the comparative strength of mortars made with a Rosendale cement, an English Portland cement, and also a mixture composed of equal parts of each.

TABLE No. 15.

KIND OF MORTAR.	1 Week.	1 Month.	6 Months	1 Year.
Rosendale Cement, 1; Sand 2	26	60	125	180
Rosendale Cement, 0.5. } Sand, 2.	79	138	268	273
Portland Cement, 0.5. }				
Portland Cement, 1; Sand 2	126	169	279	325

In the foregoing tests the mortar made with mixed cement had an unexpected strength approximating to that of mortar made with pure Portland cement. In the following series of tests of mortars made with lime of Teil, a fine-ground French Portland cement, and the lime and cement mixed, the strength of the mortar made with the mixture is almost exactly a mean between those of the other two mortars, as also the cost of the mixed cement is a mean between the costs of the other two.

TABLE No. 16.

KIND OF MORTAR.	1 Week.	1 Month	6 Months.	1 Year
Lime of Teil, 1; Sand 2	40	65	150	195
Lime of Teil 0.5 Portland Cement, 0.5. } Sand 2.	100	135	255	290
Portland Cement, 1; Sand, 2.	170	265	350	365

The best Portland cements sometimes do not set within an hour, which preclude their use for wet work. In such cases quick-setting cement should be added to them. Roman cements can be procured which will set in from one to five minutes. Mixtures of Roman and Portland cements were often used on the Main Drainage works. Such mortars would set about as quickly as if made with Roman cement alone, and would acquire great subsequent strength due to the Portland cement contained in them. This was proven by many experimental tests.

It is probable that mixtures of any good cements can be used without risk, but before adopting any novel combination it would be wise to test it experimentally.

EXPERIMENT No. 12.

Engineers are accustomed to require that only clean sand and water shall be used in making mortar. Occasionally these requirements cause delay and extra expense. This experiment was designed to ascertain how much injury would be caused by the use of sand containing moderate proportions of loam. In mixing the mortar for these briquettes, sand containing 10 per cent of loam was used in the place of clean sand. Each figure in the table is an average (in pounds per square inch) of ten breakings.

TABLE No. 17.

ROSENDALE CEMENT, 1; SAND, 1.5; LOAM, 0.5

One Week.	One Month.	Six Months.	One Year.
21	46	200	221

The tests do not give very decisive results. For one week and one month, the breaking loads are not much more than one-half what would have been expected with clean sand. For six months and a year, they are fully equal to ordinary mortar.

EXPERIMENT No. 13.

This experiment was similar to the foregoing one except that clay instead of loam was added to the mortar. Clay when dissolved or pulverized consists of an almost impalpable powder, with particles fine enough to fill the interstitial spaces among the coarser particles of cement. By adding clay to cement mortar a much more dense, plastic and water-tight paste is produced, which was occasionally found convenient for plastering surfaces or stopping leaky joints. Each figure in the Portland cement series of tests is an average from about 15 briquettes; those in the Rosendale cement series are averages from 10 briquettes.

TABLE No. 18.

ROSENDALE CEMENT.

	Cement. 2 Clay. 1.	Cement. 1 Clay. 1.	Cement. 1 Sand. 1. 5	Cement. 1 Sand. 1. 5 Clay. 0. 15	Cement. 1 Sand. 1. 5 Clay. 0. 3	Cement. 1. Sand. 1. 5 Clay. 0. 45
1 Week	32	23	50	52	34	33
1 month	108	52	123	116	101	100
6 months	303	206	217	248	247	236
year	208	209	262	290	265	261

PORTLAND CEMENT.

	Cement. 2 Clay. 1	Cement. 1 Clay. 1	Cement. 1 Sand. 2	Cement. 1 Sand. 2 Clay. 0. 2	Cement. 1 Sand. 2 Clay. 0. 4	Cement. 1 Sand. 2 Clay. 0. 6
1 Week	185	192	150	197	185	145
1 month	263	271	186	253	245	203
months	318	322	320	361	368	317
Year	303	301	340	367	401	384

The tests seem to show that the presence of clay in moderate amounts does not weaken cement mortars.

It was feared that the presence of clay in mortars exposed to the weather might tend to make them absorb moisture and become disintegrated. To ascertain whether this would be so, sets of briquettes were made, one set of Portland cement and sand only, the other containing also different amounts of clay. They were allowed to harden in water for a week, and were then exposed on the roof of the office building for two and one-half years, when they were broken. All of the briquettes appeared to be in perfectly good condition, with sharp, hard edges. Their average tensile strengths in pounds per square inch are shown in the following table:

TABLE No. 19.

Portland cement 1	Sand 2		402
"	"	Clay 0.5	263
"	"	" 1.0	256
"	"	" 1.5	182
"	"	" 2.0	178

The mortars with clay show a very fair degree of strength, and the tests confirm the belief that the presence of clay works little, if any, harm. Tests of mortars made with lime and clay also gave favorable results. Such mortars would stand up in water. The subject is worthy of further investigation.

EXPERIMENT No. 14.

Occasionally, for stopping leaks through joints in the sewers, it was found convenient to use cement mixed with melted tallow. The tallow congealed at once and held the water while the joint was being calked. Briquettes made of melted tallow mixed with Portland cement and sand, equal parts, acquired, in one week, a tensile strength of about 40 pounds to the inch. After a month, six months and a year, they were little, if any stronger. It was thought that possibly the ammonia in the sewage might gradually saponify and dissolve out the grease, leaving the mortar to harden by itself. Briquettes of cement and tallow were kept in water to which a little ammonia was added from time to time. After a year or two the briquettes had swelled to about double their former size, but the cement had acquired no strength.

EXPERIMENT No. 15.

Having occasion to build with concrete a large monolithic structure in which a flat wall would be subjected to transverse stress, it was considered necessary to make experiments to find the comparative resistance to such stress, of concrete made with different cements and with different proportions of sand and stone.

The cements used in the tests were an English Portland and a Rosendale, both good of their respective kinds. Medium coarse pit sand was used, and screened pebbles about an inch or less in diameter. The beams were 10 inches square and 6 feet or less long. They were made in plank moulds resting on the bottom of a gravel pit about 4 feet deep. After the concrete had hardened sufficiently, the moulds were removed, and the undisturbed beams buried in the pit and left for six months exposed to the weather. They were then dug out and broken with the results given in the table. The total breaking loads are given, including one-half of the weights of the beams, which averaged about 150 pounds per cubic foot. The constant, c, is obtained for the formula—

$$w = \frac{d^2 \times b}{l} \times c,$$

in which

w = center breaking load in pounds.
d = depth of beam in inches.
b = breadth of beam in inches
l = distance between supports in ft.
c = a constant.

Since c has an average value, and there were generally more beams of one length than of the other, the value of c as given does not exactly correspond with either load in the table.

TABLE No. 20.

PROPORTION OF MATERIALS.			AVERAGE CENTER BREAKING WEIGHT IN POUNDS.		Average Modulus of Rupture in lbs.	Average Value of c in lbs.
Cement.	Sand.	Stone.	Dist. bet. Supports, 2' 4½"	Dist. bet. Supports, 5'.		
Rosendale						
" 1....	2	5	1782	690	67	3.7
" 1....	3	7	Beams broke	in handling.		
Portland						
" 1....	3	7	3926	1935	176	9.8
" 1....	4	9	3648	.....	146	8.1
" 1....	6	11	2822	1190	112	6.2

The table shows that concrete has a rather low modulus, especially when made of Rosendale cement. When transverse stress is to be opposed it is very important to give ample time for the concrete to harden.

EXPERIMENT No. 16.

Many of the main drainage sewers were either built or lined with concrete, which was always smoothly plastered with a coat of mortar. It was important that this surface coat should be especially adapted to resist abrasion. This experiment was made to ascertain the best mixture for the purpose. Different mortars were formed into blocks 1½ inches square, and, after hardening under water for 8 months, were ground down upon a grindstone. The blocks were pressed upon the stone with a fixed pressure of about 20 pounds. A counter was attached to the machine, and the number of revolutions required to grind off 0.1 inch of each block was noted. The cements used in the test blocks were a rather coarse English Portland and a fair Rosendale.

The curves (Plate V) show the results obtained. In making these curves the resistance to abrasion opposed by the Portland cement mortar in the proportion of 1 part cement and 2 parts sand is assumed to be 100, and the resistance of other mortars is compared with it. The effect of the grinding upon the test blocks is noted on the curves, and explains the somewhat striking results.

It appears that cements oppose the greatest resistance to abrasion when combined with the largest amount of sand which they can just bind so firmly that it will grind off and not be pulled out. A little less or a little

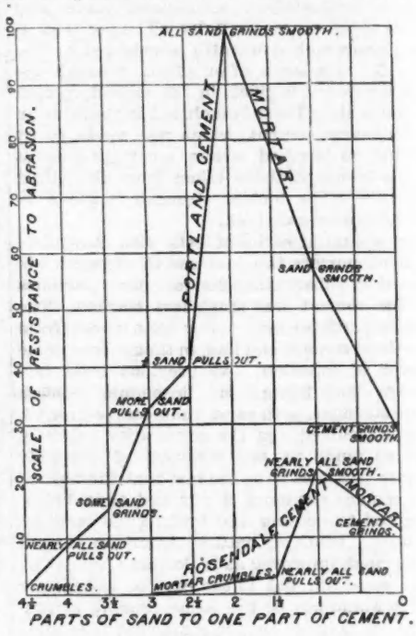

PLATE V.

more of sand may greatly lessen the resistance. For any given cement the proper amount of sand would, probably, have to be ascertained by experiment.

EXPERIMENT No. 17.

It is a prevalent belief among masons that cement, even when it contains no free lime, and does not check, expands considerably after setting. It is stated that brick fronts laid with cement mortar (especially of Portland cement) have been known to bulge, and even rise, owing to expansion in the mortar. Experiments were made to ascertain what truth there was in this belief. Several dozens of glass lamp chimneys were filled with mortars made of various brands of American and Portland cements, both neat and with different admixtures of sand. The chimneys were immersed in water, and, without exception, began to crack within three days. New cracks appeared during the following ten days, after which time hardly a square inch of glass remained which did not show signs of fracture. This showed that the cement certainly expanded, though very slowly, and that the expansion continued for about two weeks. None of the cracks opened appreciably, however, so that the *amount* of expansion, which was evidently slight, could not thus be even approximately determined.

A number of 10-inch cubes were then made of similar mortars, with small copper tacks inserted in the centers of all the sides. Some of these cubes were kept in the air, and others immersed in water, and the sizes of all of them were measured frequently by callipers during 6 months. The increase in size did not in any case exceed .01 inch, and may have been less. This indicated that, while cement mortars do expand, the increase in bulk in any dimension does not exceed .001 part of that dimension, and is too slight to be of consequence. In the case of the walls before referred to, supposing them to have been 80 feet high, with five ½-inch joints to each foot, the total height

TABLE. No. 21.

MIXTURE.	KIND OF CEMENT.	1 Day.	1 Week.	1 Month.	6 Months.	1 Year
Neat Cement	Untreated	124	135	140	164	186
	Selenitic	149	168	171	282	273
Cement, 1, Sand, 1.5,	Untreated		121	176	296	316
	Selenitic		120	158	276	356
Cement, 1, Sand .2,	Untreated		92	154	259	305
	Selenitic		103	133	226	276
Cement 1, Sand, 4,	Untreated		38	87	158	168
	Selenitic		49	97	167	164

of mortar would have been 100 inches, and the extreme expansion of the whole could only have been .1 inch. It is probable that the apparent rise was merely a difference in elevation caused by settlements of partition or side walls laid with weaker and compressible mortar.

EXPERIMENT No. 18.

It having been reported that cement mortars in contact with wood had sometimes been found to be disintegrated, as if they might have been effected by the wood acids, this experiment was made to see if any such effect could be detected. About a dozen boxes were made, each formed of five different kinds of wood, viz., oak, hard pine, white pine, spruce and ash. The boxes were filled with different cement mortars, and were some of them submerged in fresh and others in salt water. Briquettes were also made of cements mixed with different kinds of sawdust. At the end of a year no effect upon the cements could anywhere be detected.

EXPERIMENT No. 19.

Engineers are accustomed to insist on cement mortars being used before they have begun to set, and on their being undisturbed after that process has begun. With cements which set quickly workmen are tempted to retemper the mortar after it has begun to stiffen. Some experiments were made on mortars which were undisturbed after first setting, and others which were retempered from time to time. Unfortunately all of the conditions of these tests were not accurately recorded, and the results are not considered trustworthy. The following series of tests, which represents an extreme case not met with in actual practice, may be of interest.

A mortar made of one part of Portland cement and two parts of sand was allowed to harden for a week. It was then pulverized, retempered and made into briquettes. These subsequently acquired the following tensile strength in pounds per square inch:

1 week	07
1 month	13
6 months	49
2 years	93

Under the circumstances it is somewhat surprising that the mortar developed as much strength as it did. Good tests to elucidate this subject are much needed.

EXPERIMENT No. 20.

A brand of "Selenitic" cement was offered for use on the work, and was said to possess great merits. It was made by treating an ordinary American cement by a patented process. It was tested by comparing it with an untreated sample of the same cement of which it was made. In Table No. 21 are the results of the tests.

The breakings are somewhat irregular, but seem to show that this cement was made somewhat stronger by the selenitic process of treatment when tested neat, but was little, if at all, improved for use as a mortar; not enough, certainly, to compensate for the higher cost.

ENGINEERING NEWS Three months for One Dollar.

Fuel of Large Steamers.

Ocean steamers are large consumers of coal. The Orient line, with their fleet of ships running to Australia every two weeks, may be mentioned. The steamship Austral, went from London to Sidney in thirty-five days, and consumed on the voyage 3641 tons of coal. Her coal bunkers hold 2750 tons. The steamship Oregon consumes over 330 tons per day on her passage from Liverpool to New York. Her bunkers will hold nearly 4000 tons. The Stirling Castle last year brought home in one cargo 2200 tons of tea, and consumed 2800 tons of coal in doing so.

Immense stocks of coal are kept at various coaling stations, St. Vincent, Madeira, Port Said, Singapore, and others; the reserve at the latter place is about 20,000 tons. It is remarkable with what rapidity these steamers are coaled. For instance, the Orient steamship last year took in over 1100 tons at Port Said in five hours.

Durability of Leather.

A correspondent to The British Journal of Photography speaks of leather from a photographic standpoint of view in the following manner:

Generally speaking, leather is a perishable substance, especially when it is a question of preservation for thousands of years. Supposing it to be carefully kept in a normal atmosphere, it may be expected to last a little over 700 or 800 years. Leather is injured by damp, by excessive dryness, by sulphurous vapors from burning coal gas and by salts sometimes present in the soil. Peat sometimes preserves and sometimes destroys animal remains, according to the salts it holds in suspension. Leather sandals have sometimes been preserved for ages deep in peat bogs. The gravedigger in Hamlet states that corpses will lie eight or nine years in the grave before they rot, and that of a tanner lasts nine years, because his hide is so tanned with his trade.

Perhaps the oldest specimens of leather in the world have been found in Egypt in tombs or mummy cases, in which they were inclosed once for all, beyond the reach of disturbance. The oldest piece of Egyptian leather in the British museum is the Bremner (Rhoid) scroll containing a portion of the ritual of the dead. Its date is about 1800 B. C., and the scroll is now perfectly preserved in a tin case; the leather is so powdery that its custodians are almost afraid to touch it; the color is about that of bright and light new oak sole leather, and perfectly clean. There are many leather sandals in the museum dating about 1300 B. C., generally rotton, torn and distorted—some of them are pretty tough, however. The leather roll of Cheops, regarding the dedication of the temple, may be of the date of about 2000 B. C., and is perhaps the oldest piece of leather in the world. The British museum possesses an elaborate Egyptian leather sword-belt of about 500 or 600 B. C.; it is green and discolored; a casual observer might take it for bronze.

Such durability as leather possesses is unlikely to be found in the majority of gelatine films, which may be a little hardened during the manipulations, but not much, except when treated with alum.

In no case is it likely that a gelatine film is properly tanned in the ordinary manipulations, notwithstanding the use of alum. To avoid the tedious process of ordinary tanning, skins have been sometimes treated with alum and salt, more especially in Hungary, but an inferior leather was the result. All attempts to shorten the process of tanning have failed; the slow molecular changes must be allowed to go on months, or an inferior leather is the result. The quality of the leather is influenced by the vegetable astringents ussd in the process; some give soft and spongy, others hard and heavy leather; slow tanning with oak bark gives about the best result.

India and Mexico.

The experience of the Government of India in the building and operation of railways is of interest to Mexico, where the railway era opened much later in the century. The Government of India entered upon a broad and ultimately successful policy of railway construction as early as 1853, and between that date and 1873—a period of twenty years—nearly all the railways built in India received from the Government a guarantee of 5 per cent. interest. Since 1873 the Government itself has entered on the work of railway construction, and where it has made an exception to this rule and granted concessions it has only guaranteed from 3½ to 4 per cent. interest. There are now some 11,000 miles of railway in actual operation in India, and about 2,000 under construction. The amount of capital invested in the railways built by British capital on which interest has been guaranteed by the Indian Government is $496,383,000; the government itself has invested in its own lines $175,194,000, and the native States have built roads to the value of $14,599,000. Thus over $686,000,000 have been invested in the railways of India. The payment of interest on the guaranteed lines and on loans for the State lines up to 1882 was $118,255,000 in excess of the revenue from railways. Latterly, the railways of India, have generally been paying full interest out of their earnings, and, in some cases, have earned a surplus. It is the present policy of the Government to construct 500 miles of new railway every year for the next five years. The Government has grounded its railway policy on several motives, the most important of which are, first, the development of the resources of the country; second, protection against famine; third, the greater ease with which troops can be sent to all parts of the empire. The railway policy of the Government has justified itself; the great Eastern empire has been consolidated and made easy to govern, and the common people have been guarded against the terrible ravages of famine. Newspapers here which are continually assailing the far-reaching policy of the Government in the construction of railways and which are spending their time and energy in ignorant criticizing details of railway management, would do well to study the history of East Indian railway construction, and the enormous benefits conferred by railroads on the people of India, a country, which owing to railways, is now able to compete with Russia and the United States in supplying England with wheat.—*From the Mexican Financier.*

A GOOD copying-ink is made by dissolving ½ oz. of gum and 20 grains of Spanish liquorice in 13 drachms of water, and adding to it a drachm of lampblack previously mixed with a teaspoonful of sherry. If the lampblack is greasy, it should be heated to redness in a covered crucible.

Engineering News

AND

AMERICAN CONTRACT JOURNAL.

Tribune Building, - - - New York City.

THE ENGINEERING NEWS PUBLISHING CO. PROPRIETOR.

PUBLISHED EVERY SATURDAY.

CONDUCTED BY

GEO. H. FROST, - - - Assoc. Am. Soc. C. E.
D. McN. STAUFFER M.Am.Soc.C.E.: M.Inst.C.E.

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WE must congratulate the American Society of Civil Engineers upon the very marked success of the new departure in the manner of holding its Annual Convention. Previous conventions were also successful in their way, but in important work done, in the general interest manifested, and in the fulfillment of the expressed purpose of these yearly meetings, the one of last week certainly exceeded all others.

It has been proven that the selection of a somewhat isolated place of meeting, and the absence of a local committee has its advantages in spite of opinions to the contrary. The local membership in this case was nil, and as a consequence no time was consumed in excursions intended merely to exhibit the business advantages of the surroundings, or in responding to the social demands of citizens who, with the kindliest feelings in the world, yet seriously interfered with the business of the convention. There was no taxing of the local membership or their neighbors; the convention paid its own way, and for once fully carried out its programme untrammelled by the surroundings, and in a manner both interesting and profitable.

The attendance was unusually good in the professional standing of the men who were present; there were very few mere seekers after pleasure, and the papers presented were attentively listened to, and discussed with vigor and intelligence. Pride in the association was evident on all sides and was pardonable, for we doubt if any professional body could have been represented by a better class of men in relatively the same numbers.

We ourselves must acknowledge somewhat of a change of heart in this matter of holding annual meetings. We always did, and still do, regard this convention as a feature essential to the prosperity of the Society, and the one most likely to extend its influence and rapidly increase its useful growth. In past years we feared that business alone would not attract a sufficient number of its scattered members to any one remote locality, and that excursions to points of interest and social events were absolutely necessary in this connection. For these reasons we were somewhat opposed to interfering with methods that were evidently popular. But after the experiment of last week we think differently, and in commending the new departure we believe we echo the feelings of the engineers who were at Deer Park.

In some few points still further improvement can be made, notably in the manner of announcing and presenting the papers. But, as it is now a proven fact that professional papers can be read and discussed, and are no longer merely intended to stop gaps in a week mainly devoted to other matters than those appertaining to engineering, this defect can doubtless be remedied. As we have before suggested, all of the papers intended for the convention should be sent in at least 40 days before the time of meeting, and advance copies put into the hands of all interested members. Time could be saved at the convention by then only reading the paper by title, and the bulk of the meeting could be devoted to the more interesting and animated personal discussion. A paper must be studied before it can be properly and most usefully debated, and this study of the subject should precede the convention and take place in the quietude of the office or home. We are aware that some papers will be late, but this too might be prevented if the rule were made absolute, and the time of delivery definitely fixed.

Annual Convention of the American Society of Civil Engineers.

The majority of the members of the Society arrived in Baltimore at noon of Monday, June 22nd, according to the previously published programme, and made their headquarters at the Carrollton House. On the afternoon of Monday the party was divided, one and the larger portion embarked on the steamer Latrobe, and after first visiting the terminals of the B. & O. R. R. Co., at Locust Point, viewing the timber dry-dock and witnessing the very admirable arrangement of fire protection at that point, sailed down the Patapsco to Fort McHenry and examined that historic structure. The next stop was made at the unfinished Fort Carroll, a magnificent specimen of masonry as far as completed, but about as useless for defence against the armanent of modern war vessels as would be the few smooth bore guns with which it is armed, against the armor of the present day. The party finally landed at Curtis Creek where the B. & O. R. R. Co. are making extensive improvements for the shipment of freight, and inaugurating a Coney Island resort for the inhabitants of the Monumental City. A special train conveyed them to the city by way of the old Mount Clare route.

The other party, made up of the more seriously disposed members of the Society, left the city under the charge of Mr. Robert K. Martin, Chief Engineer of the Water Department, and examined the water-works at Loch Raven, but not being one of that party we can only speak of these famed works from the hearty expressions of praise by the hydraulic experts who were with Mr. Martin. On the evening of Monday many of the members and the ladies accompanying them accepted an invitation to witness comic opera at the Academy of Music.

On Tuesday morning a special train was put at the service of the Society by the management of the B. & O. R. R. Co., and about 9 A. M. the members and guests left Baltimore. The first stop was at the Mount Clare Shops of the Company, and somewhat over an hour was profitably spent there in examining the extensive and elaborate plant for the building of nearly everything needed in the construction and maintenance of a great trunk railway. The company at this point builds and repairs its own locomotives, passenger and freight cars, bridges, etc., and under the care of attentive and courteous officials of the company all was shown and explained to the interested visitors. The "Arabian," a locomotive of the "grasshopper" type, built in 1835, was found still in active service as a shifting engine, and doing good work.

The train was then started for Deer Park, the place of the Convention, and the journey over the fertile country lying between Baltimore and the Potomac was a rapid and agreeable one. At Harper's Ferry the party examined John Brown's Fort, the insignificant brick engine house, where the Great Civil War or 1861-65 may truly be said to have taken its origin, the ruins of the old U. S. Arsenal and the other features of this historic spot. For the remainder of the journey and the many beauties of natural scenery to be found on the "Picturesque B. & O.," we must refer to others who with more facile pen have so often painted these pictures for those not fortunate enough to see them for themselves.

The company arrived at Deer Park in the early evening, and, after some little confusion in the assignment of rooms, and the usual remonstrances and controversies between the polite clerks of the hotel and members who objected to being packed *more* than two in one bed, the travellers settled down to the comforts of a well served supper and an atmosphere due to an elevation of some 3,000 feet above the sea; overcoats in the evening and extra blankets at night were in demand, and the heat prevailing in lower regions was for the time forgotten.

The opening session of the Convention was held in an annex to the hotel at 10 A. M., Wednesday, and Mr. Mendes Cohen, long identified with the B. & O. R. R. Co., of Baltimore, was called to the chair, and made a brief but well expressed address welcoming the Society to the mountain peaks of Maryland, and congratulating the members present upon the prosperity and influence of the organization so ably represented at this convention.

The first paper was one upon English and American Railroads, by E. Bates Dorsey, now of London, and read by the Secretary, Mr. John Bogart. Mr. Dorsey made an exhaustive comparison of the two systems and explained the many points of difference as they strike the eye of an American engineer, and gave the reasons for much of this variety in the very different conditions existing in the two countries. The relatively short distances travelled by the passenger, the exclusive tastes of the people and the conservative spirit which has preserved many of the earlier traditions of railways, have given rise to and preserved a type of carriage and general equipment that could have no place in our broader land and more democratic population. This paper drew out an interesting and lengthy discussion from the members present, many of whom related reminiscenses of English travel. The statement by Mr. Dorsey that about $33,000,000 was in a short time expended in England in securing railroad legislation was especially commented upon, and Mr. Chanute thought that a like, or even a greater sum would be economically spent in this country in thoroughly examining into the reason of being of any proposed railroad and the cancelling of projects which are purely stock-jobbing enterprises and of no public benefit, He said that in the last ten years $100,000,000 had been wasted in the United States in useless railway schemes resulting in the present demorilization of traffic and rates. Mr. M. J. Becker, made some severe comments on railway legislation in this country, and said that the aim of the average member of a State Legislature seemed to be to first find out what the railroad company *did not want* and then to enact it, or put the road to considerable expense in preventing such legislation as would be detrimental to its interests. In England this preliminary parliamentary examination and argument for or against a projected railway was the most lucrative part of the practice of engineers of reputation; a retainer of fifty guineas and a per diem compensation

of from ten to fifty guineas, according to professional standing and influence, were the usual fees for such services.

Prof. Thomas Egleston, of the Columbia School of Mines, then read a paper upon "The Cause and Prevention of Decay of Building Stones." Sandstone, granite, limestone and slate had been chiefly investigated by him through a long series of years, and the scientific causes of decay, chemical and atmospheric influences, and the means of prevention of such decay, were carefully and practically considered.

The report of the Committee on the Preservation of Timber was read and discussed at length. This Committee, composed of Messrs. Chanute, Harrod, Bouscaren, Andrews, Bowditch, C. S. Smith, Putnam, Mendell and President Graff, has been investigating this subject since 1880, and the voluminous and valuable report submitted to this convention is evidence of the care and intelligent labor which they have expended upon a matter so important to the engineer and the general public of this country. As we expect to give at least an abstract of the report in another issue, we will defer further comment at this time upon the original document.

On Wednesday evening, before the assembled members of the Society and lady guests, President Graff delivered his annual address, which will be found in full in another portion of this issue. After the address Secretary Bogart exhibited, by the aid of a stereopticon a very interesting series of the famous bridges of the world, commencing with the Niagara Cantilever, and including some of the ruder specimens of native workmanship and engineering skill as seen in Mexico, Persia, India, etc.

On Thursday morning Mr. F. Collingwood read a paper upon the Preservation of Forests. In summing up he stated that the supply of white pine in the United States would certainly be exhausted before the end of the century, and that the same result was predicted for the Canadian forests. Of Southern pines there was stated to be about 150 years supply; spruce east of the Mississippi would probably last 25 years, but large quantities still existed in Canada and the West; the hemlock supply in the East is about the same as spruce, and will soon be exhausted in Pennsylvania, New York, and the Eastern States, and the price has doubled in 25 years. Among hard woods black walnut now commands $110 per M. at wholesale, and the supply is not equal to the demand, and ash and oak has more than doubled in price in the quarter of a century.

Mr. Collingwood thought that while the matter, to engineers, was now simply one of cost it was their duty to economize in the use of timber in construction, and to prevent by all possible means its waste by forest fires. Cultivation of timber was recommended, and the influence of timbered land upon the conservation of water supplies was pointed out in equalizing the flow of streams and preventing floods. He thought that circumstances warranted the expectation that the replanting of forests could be easily accomplished, and reasonable care would assure abundance of timber for generations to come.

The members present had much to say upon this subject; Mr. E. P. North suggested that land devoted to the growth of timber be free from taxation owing to the long time that it took the crop to mature; 100 to 120 years being the time usually required for white pine to become good, commercial lumber. Mr. F. Collingwood remarked that forest land can be made to pay at a comparatively early period by planting the trees thick and then thinning out; Prof. Egleston said that according to German experience, forests would begin to yield an income after 10 or 15 years as a fuel; in our own country cottonwood would grow to diameter of 12 inches in the time stated; laws were sadly needed relating to the growing of timber; what is wanted is legislation rather than science. Mr. A. M. Wellington instanced Mexico as illustrating what can be done in a country where timber is scarce; he did not deny that a lack of wood was a great inconvenience, though he thought that if used less, our danger from fire and decay would be decreased, and that the money annually wasted in disastrous conflagrations would more than compensate for more substantial construction.

Thursday continued the discussion upon the preservation of timber. The first paper was upon the Specifications for Strength of Iron Bridges, by Jos. M. Wilson, discussed by the bridge experts present. Written discussions upon the paper of Mr. Schneider upon the Niagara Cantilever Bridge, were also submitted by E. B. Dorsey, Douglas Fox, and Benjamin Baker, of London; the latter gentlemen were surprised at the heavy percentage of steel plates rejected at Niagara, and stated that out of the 12,000 tons of steel already delivered for the Forth Bridge, not more than half a dozen plates had been thrown out for imperfections.

On Thursday afternoon a special train was placed at the disposal of members and their guests by the Baltimore & Ohio R. R. for a trip to the foot of the western slope of the mountains, under the guidance of Messrs. Jas. L. Randolph, Bolling, Harris, Cohen, C. H. Latrobe and Col. Merrill, all familiar with the early history of the railroad. The road is a very winding one, but every foot of the way has an interest for the lover of the picturesque and grand in nature; the claim is made that the valley of the Cheat River contains scenery unsurpassed in any region east of the Rocky Mountains and the claim seems certainly well founded. Stops were made at Cheat River bridge at the foot the 116 feet grade; at Tray Run Viaduct, an antiquated bit of cast-iron construction now being replaced by the company, and one of the first American designs of the well-known engineer Rudolph Fink; at the Buckhorn wall, a massive retaining wall taking the place of a previous viaduct, and at the Kingwood tunnel, where many of the members took a hot climb over the line of the temporary track and its "switch-backs" which were used during the tunnel construction, and have found a place in engineering literature as among the steepest grades ever climbed by the iron horse.

On Thursday evening a business meeting of the society was held. The report of the Committee on the Preservation of Timber was accepted and the committee finally discharged after an effort had been made to continue it in its useful but onerous labors. The final report of the Committee on a Uniform System for Test of Cement, presented at the annual meeting in January and returned to the committee for revision in some points, was again presented and read. This report gave rise to considerable comment, and as a minority report was also presented objecting to the embodying of specific cement tests and ranges of tests in the body of the report, it was finally decided, after much debate, to print these tests simply as an appendix to the report. The general feeling of the members seemed to be that while a statement of such tests was valuable as given independently, it was not expedient for the Society as a body to fix any limits by giving a range of results, which might tend to check advance in the manufacture of cement, or be improperly used in the hands of ignorant or interested parties: the expressed purpose of the appointment of the committee was to recommend a uniform system of tests for the guidance of engineers, rather than to specifically state any results of present tests. The Committee on Standard Time reported progress and asked to be continued. Mr. A. M. Wellington proposed that a committee be appointed to examine into and report upon the relative form that tread and flange of a car-wheel should bear to the head of the rail; the matter was referred to the Board of Direction for action. Mr. Wellington also brought up the subject of a permanent basis for a national engineering society, and proposed that a committee of seven members be appointed by the President to confer with the various local societies and discuss the question of uniting all properly qualified engineers into one national society with local chapters, under such conditions of membership and regulations as might best serve the interests of engineers in this country. As might be imagined this question gave rise to some very lively discussion, and a varied expression of opinion as to the ultimate effect upon the present organization. The resolution was passed with an amendment by Mr. E. P. North that this committee also report upon the future policy of the Society in regard to the branches of engineering not now considered in the organization of the Society.

The Society then went into convention for the appointment of a Nominating Committee for officers of the Society for the coming year, with the following result: For the Eastern States, J. Herbert Shedd; Middle States, M. J. Becker; Southwest, Rudolph Fink; Northwest, Don. J. Whittemore, and the Pacific Coast, Col. George H Mendell. The convention then adjourned.

On Friday morning, papers were submitted as follows: New Method of Making Conventional Signs on Maps, by J. A. Ockerson; The Problem of Submerged Weirs, by Clemens Herschel, Rainfall and Rain Gauges, by Robert Fletcher, and Guard-gates at Point St. Bridge, Providence, R. I., by Wm. D. Bullock. Mr. Hutton read a paper upon the Maas Canal in Holland, and Mr. E. L. Corthell another upon the future of railroad and canals. Mr. Corthell said that canals must succumb to the modern system of railroads, and argued the advantages of ship-railways over ship-canals. The question was discussed by Messrs. North, Hutton, Collingwood and Shinn. At a business meeting convened for the further discussion of the report on cement tests, with the result already given, Mr. William Sellers offered a resolution that the Board of Direction be authorized to petition Congress to appropriate $10,000 for the construction of a small testing machine for the further and better testing of steel; the resolution was carried.

On the convention again going into session, Mr. Corthell exhibited and explained a chart of soundings taken in the present month across the head of the deepened pass at the mouth of the Mississippi. This chart showed a well maintained and deep channel and the successful solution of the original problem of constructing training works for the leading of water into the new ship channel at its head; he said that notwithstanding a popular opinion to the contrary no dredging was being done in the S. W. Pass, the dredge formerly used for trimming the sides and bottom being now at work many miles away.

Capt. O. E. Michaelis, U. S. Ordance Corps, read a paper entitled "Can we Make Heavy Guns?" The author advocated the casting of all steel guns, and read letters from experts claiming that the practical cost of such guns for metal and labor would not exceed $75 per ton; he referred to the recently perfected manufacture of drawn steel tubes and thought that our cast iron guns could be lined with this product quite as well as with imported steel tubes, as is now being done. Captain Michaelis recommends the South Boston Foundry as best adapted to the manufacture of the proposed guns; the casting pits, boring mills, 100-ton cranes, etc. were already there, and he had been assured that $100,000 would supply the steel plant required; $50,000 additional would be necessary for the moulds, extra cranes, etc. Prof. Egleston briefly referred to the methods of gun manufacture as

witnessed by him at the Whitworth and Armstrong establishments in England. He thought there was no scientific difficulty in making steel castings of 150 to 200 tons by the basic open-hearth process.

Mr. Charles Latimer followed with an interesting paper on Railroad Organization. He sketched the rise and progress of railroading and hinted at its future; he regarded pools as a failure, railroad commissioners as a necessity, and charged incompetency at the head of the company as the cause of prevalent wrecking of railroads. Mr. Latimer discussed at length the influence for good and the varied duties of the engineer and gave much useful detail in this connection.

Mr. Chas. B. Brush described and reported progress upon the Aeration of Water as introduced practically by him at the Hoboken Water-Works, N. J. These experiments were commenced about one year ago, the conditions being a water supply forced to 60,000 consumers through 14 miles of cast-iron main into two reservoirs, one 16 feet and the other 13 feet deep. The green scum which appeared on the water in the reservoirs was likened to a thick green paint without evidence of vegetable form. An analysis by Prof. Leeds of the Stevens Institute showed a deficiency of oxygen in the affected water, no sewage pollution and a growth entirely of vegetable origin. There was no trouble in the force main or in the water supplied directly from this main. It was found that the taste and smell disappeared on violently agitating the water, and this suggested the introduction of air into the supply main under a pressure of 125 pounds to the square inch by means of air-compressing machinery. The water thus aerated is white when first drawn but rapidly clears from the bottom of the glass up; it is highly prized by the consumers who delight in drinking it before the air-bubbles have escaped. The process has so far been very successful in keeping the water pure and free from vegetable growth. This paper was discussed by Messrs. Tubbs, Kuichling, Croes and Col. Merrill, and the efficiency of covered reservoirs debated.

Prof. S. W. Robinson of the Ohio State University, read a paper on Vibration of Bridges as ascertained by him from nearly 200 diagrams taken by an indicator, from various bridges and under various loading. The results, while interesting cannot be profitably repeated here without the diagrams. Mr. Wm. P. Shinn then explained a number of diagrams and drawings illustrating a paper by him on Power Brakes for Freight Engines and Cars. The Westinghouse and the American Co.'s brakes were referred to, and by means of tables and graphic charts the results of extended trials were exhibited. Mr. Shinn showed that with the best present designs the cost of application of brakes to engines and freight cars and the expenses of maintainance were comparatively very light.

The closing papers were: Strength of Columns, by Thos. H. Johnson; a discussion of Mr. Geo. H. Pegram's paper. on Formulas for the Weights of Iron and Steel Railway Bridges under Standard Specifications, by Prof. Dubois and replied to by Mr. Pegram, and a discussion of the "Levee Theory as Tested by Facts," by J. A. Ockerson. After passing resolutions of thanks to the Baltimore and Ohio R. R. Company for the many courtesies extended, and to the chairman, Mr. Mendes Cohen, and to the citizens of Baltimore for attentions at the Water-Works, the convention adjourned.

In the evening the annual banquet was held in the large dining room of the hotel; about 200 members, guests and ladies were present, and toasts were replied to by President Frederic Graff, Past Presidents Julius W. Adams and D. J. Whittemore, by Mr. Mendes Cohen, Mr. Randolph, Vice President Samuel Spencer of the B. & O. Co., Mr. Theodore Cooper and others. After the banquet the Owl Club had its usual symposium and a number of new members were initiated.

On Saturday morning at 7.15 the majority of the members again boarded the special train and started on their journey homeward, after a most profitable and pleasant Convention week. The polite officials of the company who had this train in charge, seemed determined to show their engineering travellers what could be done in the way of speed on the B & O., and although a few complained somewhat of the effects of centrifugal force in rounding some of the sharper curves, all were willing to forgive when they saw the record made on our arrival at Washington. The 206 miles between Deer Park and the latter place were run in 5h. 20m. including a number of stops; but the actual speed attained is better shown by the following statement of certain runs, deducting stoppages:—The first 102 miles was passed over in 115 minutes, then come records of—22 miles in 25 minutes, 28 in 29½, 52 in 58½, 11 in 12, 6 in 6, 4 in 4, 10 miles in 9½ minutes, 7 in 7, 12 in 13½, 16½ in 18, 16½ in 17, and on the final stretch to Washington 43 miles were covered in 49 minutes. The speed frequently reached one mile per minute, and on one 10-mile stretch it averaged 63 miles per hour. This we think can be called *very* fast railway travelling; it would startle our grandparents were they about, however slow it may seem to the generation that is to come. We should mention that the train was made up of four parlor and sleeping cars, and one combination smoker and baggage car. After a lunch at the Relay House and a transfer across the Patapsco from Locust Point, another special train was run for the Society by the Penna. R. R. through to Jersey City, arriving there at 8 P. M., thirteen hours, and 426 miles from Deer Park. For the latter courtesy, a resolution of thanks was passed on the train and an engrossed copy thereof directed to be forwarded to the Penna. Railroad Co.

List of Members and Guests.

Julius W. Adams, Consulting Eng. Dept. Public Works, New York, and Miss Adams; W. H. Atwood, Div. Eng. South Penna. R. R., Fannettsburg, Pa.; John W. Bacon, R. R., Commissioner of Conn., Waterbury, Conn., and Mrs. Bacon; M. G. Becker, Chf. Eng. P. C. & St. L. R. R., Pittsburg, Pa., and Miss Becker and Miss Baldwin; William H. Bixby, Capt. U. S. Eng's., Wilmington, N. C., and Mrs. C. T. Bixby; John Bogart, *Secretary*, Am. Soc. C. E., and Mrs. Bogart, New York City; William F. Booth, Poughkeepsie, N. Y.; H. R. Bradbury, Neuchatel Asphalte Co., New York City, and Mrs. Bradbury; Fred Brooks, Boston, Mass.; Chas. B. Brush, Chf. Eng & Supt., Hackensack W. W., Hoboken, N. J.; A. Bryson, Chf. Eng., Hartford & Harlem & East River & Conn. R. R., Washington, D. C.; John S. Bullock, Baltimore, Md.; C. P. E. Burgwyn, Asst. Eng. James River Imp, Co., Richmond, Va.; O. Chanute, Kansas City, Kan.; W. B. Cogswell, Treas. & Gen. Manager of the Solway Process, Syracuse, N. Y., and Miss Cogswell; Mendes Cohen, Baltimore, Md.; F. Collingwood, Elizabeth, N. J., Mrs. Collingwood and Miss M. B. Bonnett; Theodore Cooper, Consulting Eng., New York City: E. L. Corthell, Chf. Eng. Tehuantepec Ship Railway, New York City; Martin Coryell, Civil and Mining Eng., Lambertville, N. J., and Mrs. Coryell; C. S. Crandall, Asst. Prof. Civil Eng. Cornell University, Utica, N. Y. Mrs. Crandall, and Miss A. L. Robbins; J. J. R. Croes, Chf. Eng. Suburban R. T. R.R., Miss Croes and Miss Willet, N. Y. City, N. Y.; J. G. Dagron, Chf. Insp. Bridges B.& O.R.R., Baltimore, Md.; F. G. Darlington, Eng. Maintenance of Way, P. C. & St. L. R. R., Pittsburg, Pa.; Chas. D. Davis, County Eng. Allegheny City, Pa.; E. P. Dawley, Eng. N. J. Prov. & Boston R. R., Providence, R. I.; Jos. J. de Kinder, Gen. Supt. Phila. Water Department, Mrs. de Kinder, Mrs. Reeder and Miss Landham; Prof. Thos. Egleston, Columbia Col. School of Mines, N. J.; Rudolf Fink, Gen. Manager & Agent of Trustees M. & L. R. R., Little Rock, Ark.; J. F Flagg, New York City; James B. Francis, Consulting Eng, Proprietors of Locks and Canals, on Merrimack River, Lowell, Mass.; Arthur J. Frith, C. E., New York City; E. A. Fuertes, Dean of Faculty of Engineering Cornell University, Ithaca, N. Y.; Chas. E. Goad, Montreal, Canada; Frederic Graff, President. Am. Soc. C. E., Philadelphia, Pa., and Mrs. Graff; Chas. E. Greene, Prof. University of Mich., Ann Arbor, Mich.; David M. Greene, Director Rennselaer Polytechnic Inst., Troy, N. Y.; Jas. H. Harlow, P. & C. E. W. & G. W. Construction Co., Pittsburg, Pa., and Mrs. Harlow; W. J Haskins, Asst. Eng. Dept. Pub. Works, New York City; W. A. Haven. Buffalo, N. Y.; J. D. Hawkes, Chf. Eng. Mich. Cent. R. R., Detroit, Mich.; Chas. Hinckeldeyn, Technical Attache to the German Legation, Washington, D. C.; F. H. Howes, New York; William R. Hutton, Con. Eng. New York City, and Mrs. Hutton and Miss Hutton; J. M. Jackson, Chf. Eng. W. V. & R. R. R. Clarksburg, W. Virginia; W. H. Jennings, Engineer C. H. V. & T. R. R., Columbus, O.; Thomas H. Johnson, Principal Assistant Engineer, P. C. & St. L. R. R., Columbus Ohio; Walter Katte, Chf. Eng. N. Y. W. S. & B. R. R. New York, & Mrs. Katte; Frank M. Kerr. Sec. Board State Eng's. of Louisiana, New Orleans, La; Louis H. Knapp, Eng. & Supt. of W. W. Buffalo, N. Y. & Mrs. Knapp; Emil Kuichling, Mem. Exc. Board of Rochester, N. Y; Charles Latimer Eng. M. of W. N. Y. P. & O. R. R. Cleveland, O.; C. H. Latrobe, Eng. Jones Falls Com. Baltimore Md. & Mrs. Latrobe; T. B. Lee, Chf. Clerk Am. Soc. C. E., New York City; Hampden S. Lewis New Orleans, La; Sidney F. Lewis, State Eng. Louisiana, New Orleans, La.; A. W. Locke, Manager Troy & Greenfield R. R.; C. A. Marshall, Johnstown, Pa.; D. E. McComb. Asst. Eng. Dist. Govt. Washington, D. C.; A. G. Menocal, Civ. Eng. U.S.N. & Mrs. Menocal; Wm. E. Merrill. L. Col. U. S. Eng's, Cincinnati, O.; O. E. Michaelis, Captain of Ordnance. Watervliet Arsenal, West Troy, N. Y.; Henry G. Morris, Philadelphia, Pa.; Henry C. Meyer, Editor "*Sanitary Engineer*," New York; Mr. J. Boyd Mixon & Miss M. C. R. Scull.; Edward P. North, C. E., New York City; Fred. S. Odell, Lawrenceville, N. J.; James Owen, Newark. N. J. & Mrs. Owen & Miss Owen; Wm. N. Patton, Eng. in charge Susquehanna Bridge B. & O. R. R. Havre de Grace, Md.; Geo. H. Pegram, Eng. Bridges & Bridges, Edge Moor Iron Works, Wilmington, Del.; Wm. A. Pratt, C. E., Clarkeburg, W. Va.; Franklin C. Prindle, C. E. U. S. Navy, Bloomfield, N. J.; Jas. C. Post, U. S. Eng's. Cincinnati, O.; Joseph R. Richards and Mrs. Richards, Boston, Mass.; B. F. Richardson, Div. Eng. B. & R. R. Phila., Pa.; Percival Roberts, Philadelphia, Pa.; Arthur H. Scott, First Asst. City Eng., Milwaukee, Wis.: Wm. Sellers, Philadelphia, Pa.; Wm. P. Shinn, Vice Prest. N. Y, Steam Heating Co., New York, Mrs. Shinn; Fred. H. Smith, Consulting Eng. Edge Moor Iron Works and Vice Prest. Baltimore Bridge Co., Baltimore, Md.; Oberlin Smith, Mrs. Smith and Mrs. Nixon, Bridgeton, N. J.; D. McN. Stauffer, Editor ENGINEERING NEWS, New York City; Geo. F. Swain, Asst. Prof. Civ. Eng., Inst. of Technology, Boston, Mass.; J. Nelson Tubbs, Chf. Eng. Rochester Water Works.; Karl von Wagner, C. E. Pittsburgh Pa. care Austrian Consulate; Prof. Watson, Boston, Mass.; A. M. Wellington, Editor *Railroad Gazette*, New York City.; Nelson J. Welton, Waterbury, Conn., & Mrs. N. J. Welton; Edmund B. Weston, Asst. City Engineer, Providence, R. I.; John W. Weston, Managing Editor *American Engineer*, Chicago, Ill.; Don J. Whittemore, Chf. Eng. C. M. & St. Paul R. R., Milwaukee, Wis., Mrs. Whittemore, son and daughter; John Wilson, Philadelphia, Mrs. Wilson, Miss

E. B. Wilson and Miss J. M. Wilson; C. J. H. Woodbury, Inspector Factory Mutual Insurance Co., Boston, Mass.; Albert Goodman, *Balt. American*, Baltimore, Md.: Edgar Goodman, Asso. Press, Baltimore, Md.; Wm. H. Wiley, Publisher, New York City; S. H. Chittenden, Washington, D. C.; Chas. L. Strobel, Con. Eng. Keystone Bridge Co. Pittsburg, Pa.; J. Foster Crowell, Eng. of Con. Pennsylvania, R. R., Pittsburg, Pa.; G. Lindenthal, C. E., Pittsburg, Penna;. Charles Ackenheil, B. & O. R. R. Co., Baltimore, Md.; Prof. S. W. Robinson, Ohio State University, Columbus, Ohio.; W. G. Nicolls, Pottstown, Pa.; Gen. J. J. Dana. Stephen S. Haight C. E., West Farms, New York City; F. O. Norton and Mrs. Norton, New York City.

The Value of Engineering Advice.

We believe it to be an admitted fact that of all professional services those of the engineer are receiving the smallest amount of pecuniary compensation. Why this should be so it is difficult to understand, if we take into consideration how beneficial to mankind are the services of the engineer, whatever the special branch may he to which he devotes his studies, energies and talents. Indeed, it is impossible at the present day to imagine at all what our century would be without him. Everywhere and on all sides do we perceive the lasting monuments of his skill, ingenuity and perseverance, and it is but fair to say that the honors are equally divided between the civil, the mechanical, the hydraulic, the bridge, railroad, mining and sanitary engineer.

Yet it is but seldom that we find engineers amassing a fortune unless possibly they be contractors for large works. With but few exceptions they are mostly underpaid, hard-working men, seldom as successful, from a pecuniary point of view, as the more fortunate medical practitioner, or the lawyer.

A few instances have recently been communicated to us, which illustrate the truthfulness of the above statements. A popular and growing manufacturing town, finding it impossible to rely any longer upon leaking cesspools, etc., for the disposal of the household wastes, decided to adopt and, if possible, to carry out a system of sewerage. Not having a city engineer competent to take the matter in hand, it is proposed to raise a fund of five hundred dollars, and to invite a number of civil engineers to prepare competitive plans for the sewerage and sewage disposal of the town, the prize of five hundred dollars to be awarded to the plan which would be considered the best by the town authorities. There is no topographical map, no street survey, no levels available; in other words, it is expected that each of the competing engineers would make his own survey, to enable him to prepare plans and estimates and to make a report advising about the best system of sewerage. It is hard to conceive of a more unjust or more impracticable plan than the method suggested. No engineer in good standing could undertake to make a reliable and accurate topographical survey for the sum named, to say nothing of preparing a plan of sewerage and sewage disposal. When will our communities open their eyes to the impracticability of such schemes? When will they show intelligence enough to perceive that the only way of doing such work is to engage, at proper remuneration, one trustworthy engineer of reputation, and to commission him with the preparation of the preliminary surveys, plans and estimates? For in this way only can future troubles, bad execution of the work and useless expenditures in construction be avoided.

Another instance from actual practice which has a bearing upon the question discussed, although not involving any grand engineering scheme, afford such a useful lesson, that we will briefly relate it. A wealthy gentleman of culture and refinement recently built a house in a charming suburb of one of our large cities, and being a well informed man, had determined to have the drainage of the house as perfect as possible. He had accordingly decided to abolish the disgusting cesspool, and to substitute for it the subsurface irrigation system. He consulted a civil engineer about the work and was advised under no circumstances to carry out the system by contract, but to hire his labor, buy the material needed for the work, and to pay a moderate fee for professional advice to the engineer. The engineer's estimate of all the expenses required for the work was about ten hundred and fifty dollars. The gentleman, however, insisted upon having the work done by contract, claiming that he had received bids to put in the work called for, for one hundred and fifty dollars. In vain did the engineer protest, trying to explain that a contractor, if he would not have to work according to plans and specifications, would put in only such material, such a size of flush tank, and such a number of feet of sub irrigation pipes as he could afford to put in, with a reasonable allowance of profit, for the sum specified, and that the system might accordingly prove entirely insufficient for the gentleman's house. The engineer's advice was not heard, and the result was, as might have been expected, that after only a few months' use the gentleman himself admitted that there were more or less foul odors from the irrigation field, a thing which never ought to occur in a properly devised system, that the ground was evidently oversoaked and could not take care of the water, which clearly proved that either the tiles had been improperly laid and become choked, or else what is more probable, that the amount of piping laid, and the area of the irrigation field was insufficient to take care of all the water used in the house. Had the engineer's advice been followed, and the moderate fee which he asked for professional services and superintendence of the construction of the work been allowed, all the trouble could have been readily avoided.

In all engineering questions, but in questions of sewerage and sewage disposal in particular. it is well not to begin the work in a hap-hazard manner, but to employ competent engineering skill to make proper surveys, plans and specifitions, and a report clearly explaining the system, and not to attempt to have the work carried out by speculative or inefficient contractors, and to think that, because one has read books treating on the subject one is competent to devise and superintend the execution of such work.

The Introduction of the "Freezing Method for Excavating into the United States.

It seems that the very novel method of removing the difficulties in excavating through troublesome waterbearing materials, such as are met with in the construction of deep foundations, shafts and subaqueous tunnels, which consists in simply freezing a solid wall about the part to be excavated, is about to be put into use in this country.

The method is already in extensive use in Europe and is proving a most efficient and even economical way of executing works that are otherwise impracticable or impossible. In Germany a number of shafts have been sunk through quicksand to depths impossible to attain by the pneumatic process and negotiations are now pending for the application of the method to a railway tunnel near Lyons, France. The beauty of the process is its absolute certainty of success in all cases, and as we are informed, the fact that its cost can be accurately determined beforehand. All the American patents have been purchased by Genl. Wm. Sooy Smith & Son who have organized "The Poetsch-Sooysmith Freezing Company (Office 2 Nassau St., New York) which is now in condition to undertake the execution of work to which the freezing method is specially adapted.

Though Germany has taken the lead of us in this new step forward in engineering science, we shall hope that American energy will soon put us to the front in the new and promising field which this remarkable process seems destined to open up.

PERSONAL.

THE Louisville Asphalt Varnish Company has found the demands of Trade in the Eastern States such as to require the opening of an office in New York City. They have secured the services of Mr. Frank A. Cleaveland, lately with the Dighton Color Works, as Resident Agent, with office and Depot of supplies at 174 Front St.

American Society of Civil Engineers.

The final meeting for the season was held at the House of the Society on Wednesday evening, July 1. The attendance was small and the only business transacted was the annoucement of the election of the members named below. The next meeting will be held Wednesday evening, Sept. 2nd.

FOR MEMBERS: Herbert Leander Aulls, formerly Chief Assistant Engineer, Denver and New Orleans Railroad; recently First Assistant City Engineer of Denver, Col.; now with Messrs. Raymond and Campbell, Bridge Engineers and Contractors, of Council Bluffs, Iowa, and U. S. Deputy Surveyor for Colorado, Council Bluffs, Iowa.

Lewis Kingman, recently Chief Engineer, Chihuahua Divi ion Mexican Central Ry.; now Assistant Engineer Atchison, Topeka and Santa Fe Railroad. Topeka, Kansas.

Alonzo Tyler Mosman, in charge of Primary Triangulation and Astronomical Party, U. S. Coast and Geodetic Survey, Beverly, Mass.

Benjamin Franklin Richardson, formerly Division Engineer Jersey Shore, Pine Creek and Buffalo Railway, now Division Engineer, Delaware Division Baltimore and Philadelphia Railroad, Wilmington, Del.

Robert Parker Staats, (elected Junior, Nov. 3d, 1875.) Road-Master (Division Engineer) Eastern Division New York, Lake Erie and Western Railroad, Jersey City, N. J.

FOR JUNIORS: Henry Holbrook Gladding, City Engineer's Department, New Haven, Connecticut.

Charles Ezra Marvin, Assistant Engineer and Supervisor of Road, Henderson Division, Louisville and Nashville Railroad Henderson, Kentucky.

Aaron J. Zabriskie, recently Superintendent in charge of five miles of construction work on South Pennsylvania R. R., through Somerset Co., now First Assistant Engineer in charge of Construction of Improved Sewerage of Newark, New Jersey.

New Post Office Rules.

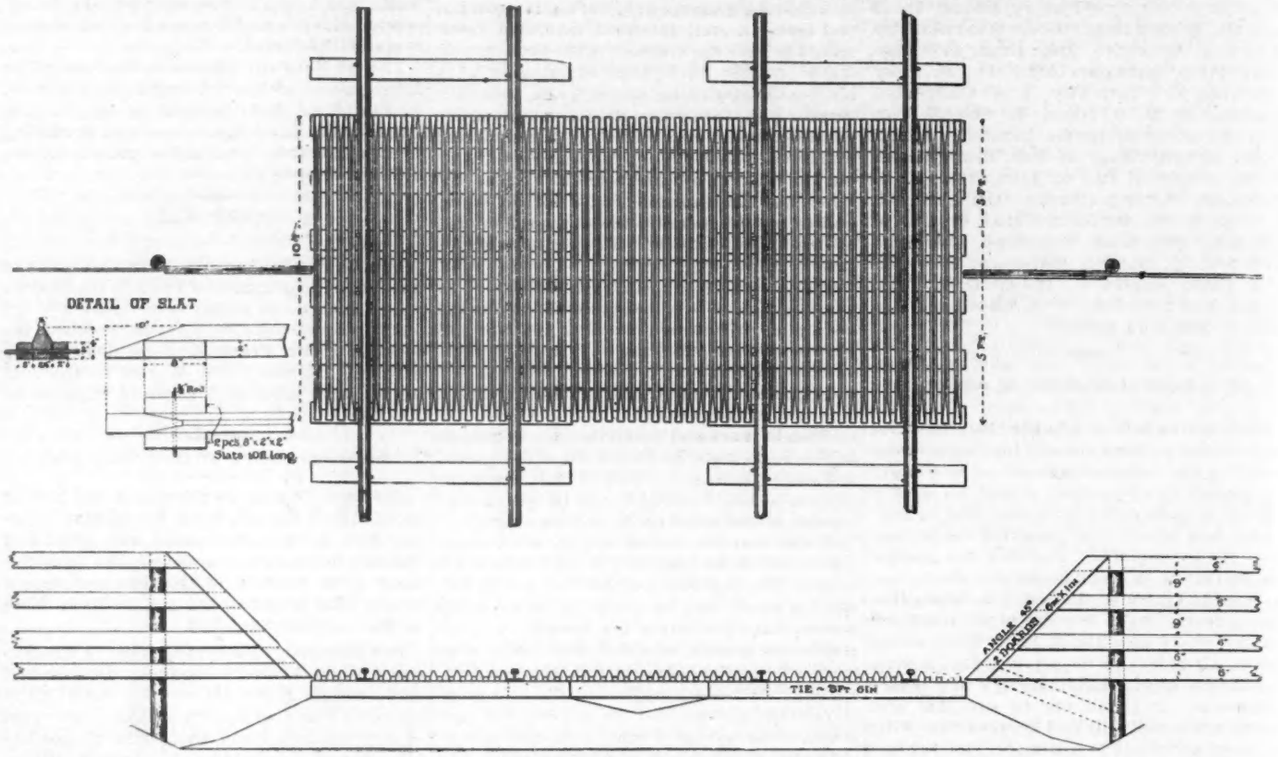
The following are the new regulations of the post office department, which went into effect the first of July:

1. Any article in a newspaper or other publication may be marked for observation, except by written or printed words, without increase of postage.

2. All newspapers sent from the office of publication, including sample copies, or when sent from a news agency to actual subscribers thereto, or to the other news agents, shall be entitled to transmission at the rate of one cent per pound or fraction thereof, the postage to be prepaid.

3. The weight of all single-rate letters is increased from one-half of one ounce each, or fraction thereof, to one ounce each or fraction thereof. The same increase of weight is allowed for drop letters, whether mailed at stations where there is a free delivery or where carrier service is not established.

FIG. 97. SLAT CATTLE GUARD WITH FENCES.



Engineers' Club of Philadelphia.

Record of special business meeting, June 20th, 1885. Past President Lewis, M. Haupt in the chair; 23 members present.

The revision of the By-Laws of the Club, as reported by the committee having that work in charge and amended at the special Business meeting on June 6th, 1885, were adopted by unanimous vote,

The following were elected members of the Club.

Active Members: Messrs. Edward Longstreth, C. A. Sundstrom, H. N. Sims, F. L. Garrison, Herbert C. Felton, Geo. W. Heuitt, W. K. Martin, A. G. Mitchell, Wm. T. Forsythe, Chas. E. Taylor, Geo. S. Cheyney, Jr,, Edward H. Johnston, Charles Wyeth, Rudolph Baizley and E. L. Corthell.

Associate Members: Messrs. Wm. S. Moorhead, W. C. Strawbridge, J. Bonsall Taylor and Justus H. Schwacke.

The Secretary presented, from Prof. J. A. L. Waddell, a communication proposing that the Club organize a system of Review of Engineering Literature, and suggesting methods therefor.

The Secretary presented, for Mr. James Beatty, Jr., a paper upon the Relative Costs of Fluid and Solid Fuels. After giving the relative advantages in economy of labor in use, reduction of weight and bulk, ease of manipulation of fire, perfection of combustion and cleanliness, the principal substances, experiments and processes are noted.

Notes and tables are given as to the compositions of different fuels, their heat units and evaporative capacities, efficiencies in furnace, prices per unit, and pounds of fuel for $1.00 and pounds of water evaporated from 212° F. for $1.00, in various localities.

The paper concludes with the following table of which the author says: "These figures are very much against the fluid fuels, but there may be circumstances in which the benefits to be derived from their use will exceed the additional cost. It is difficult to make a comparison without considering particular cases, but for intermittent heating, petroleum would probably be more economical, though for a steady fire, coal holds its own."

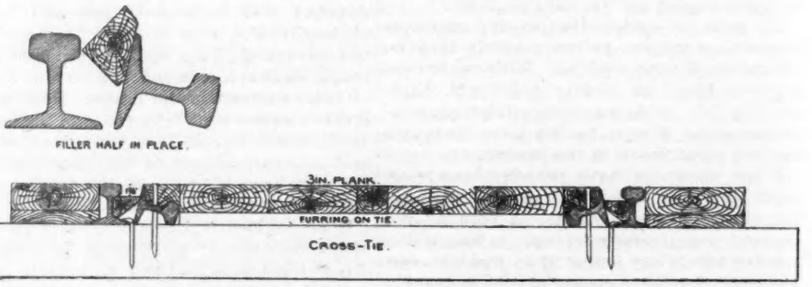


FIG. 98. PLANKED ROAD CROSSING WITH GUARD RAIL.

RELATIVE COSTS OF FLUID AND SOLID FUELS.

	Anthracite.	Bituminous	Petroleum.	Coal Gas.	Generator. Gas	Water Gas.
New York	1.00	1.08	1.71	14.92	22.90	8.70
Chicago	1.00	.71	1.50	8.72	18.30	7.00
New Orleans	1.00	.59	1.56	17.90	15.30	5.80
San Francisco	1.00	.64	1.50	8.75	9.40	3.50
London	1.00	.61	2.05	7.16	17.70	6.30
Port Natal	1.00	.90	1.21			
Sydney	1.00	.34	1.39			
Valparaiso	1.00	.44	1.03			

Prof. L. M. Haupt announced, by title, a paper upon the repairs to the Conduit of the Philadelphia Traction Company, which will probably be ready for publication during the summer.

The Secretary presented, for Mr. C. W. Buchholz, a Memorial of the late William Lorenz. reviewing his studies, his early experience, his career on the Philadelphia and Reading Railroad from topographer to Chief Engineer, his great scientific and practical ability, and last, but far from least, the extraordinary completness of his manhood.

The club adjourned for the summer, to meet at the call of the chair.

HOWARD MURPHY,
Secretary and Treasurer.

ENGINEERING NEWS Three months for One Dollar.

TRACK.*

BY W. B. PARSONS, JR., C. E.
ROADMASTER SUSQUEHANNA DIVISION ERIE R. R.

(*Continued from page 412*).

Whenever a railroad crosses a highway or other passage for vehicles at grade, arrangements must be made for letting the wagon wheels pass easily over the rails. Usually this is done by planks spiked to the ties, which planks vary in width from 8 to 12 inches and in thickness 3, 3½ or 4 inches according to the height of the rails and the requisite degree of exactness and being flush with its top. In cases of streets and very important highways the space between the rails and between the tracks should be planked solid leaving only a gap of 2½ inches along the inner side of the rail for wheel flanges. Where extensively travelled over, the planks should be nailed to the ties with wrought spikes, the ties should be sawed to give an even bearing, and to carry the planking between the tracks other ties should be interlaced withthe cross ties and be spiked to the rails of both tracks. By these means the planking is securely attached to the track and cannot be affected by frost independently of it. On top of the ties and beneath the planks there should be nailed thin strips of wood or "furring" of the same thickness as the rail base so that the plank next to the rail will lie flat and not be higher than

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the rest. On the inside of the rail in order to protect the planking at the flange space there is usually spiked a guard rail parallel to the main rail and the planking laid up against it. Instead however of standing this rail upright it is better to lay it down and arrange according to Fig. 98. The disadvantage of the first method is the liability of horses catching their toe calks in the space under the rail heads which accident is prevented by the filler shown in Fig. 98, which scheme also gives better chance for the removal of snow and ice. At important roads and farm crossings it is unnecessary to plank entirely across between either rails or tracks. One plank each side of the rail is sufficient by filling in between them with ballast which if possible should be stone or coarse gravel. To keep this filling in place a cross strip can be put in connecting the ends of the planks. The outside of this cross strip and the ends of all plank should be bevelled so as not to catch low brake rods, etc.

(TO BE CONTINUED.

American Society of Civil Engineers—Address of President Frederic Graff, June 24, 1885.

Fellow-Members and Gentlemen:

The by-laws of the society make it part of the duty of the president, "to deliver an address at its annual convention, giving a summary of engineering progress during the preceding year."

It is somewhat difficult to realize that a full year has passed over our heads since many of us met in the city of Buffalo.

A few years since it would have been hard to have recorded much advance in so short a time. Now, the strides made in inventions and discoveries are so rapid and the noble works undertaken by our profession are so numerous as to preclude at this time more than brief mention of but a few of them. Although no positively new principle may be developed, the ingenious and novel application of old ones are subjects of constant surprise.

Therefore, endeavoring to comply with the by-law above quoted, I shall review, as briefly as possible, some of the works that have been previously commenced, were in course of construction, or actually finished during the past year.

It can scarcely be hoped to make such a record as is thus prescribed attractive or novel to those before me, most of whom are actively engaged in engineering works, but it may at least serve to refresh your memories.

The progress made in railroad construction in this country has been less than for several previous years; the number of miles of new roads built, it is stated, did not exceed four thousand four hundred, upon about one hundred and sixty-six different roads, being an average of twenty-six miles to each. This is less than in any year since 1879.

There has been considerable advance made in the rate of speed upon most of the principal trunk lines, we have to record the fastest short distance, ordinary daily travel made in the world to the Baltimore and Ohio Road, on that part of its line between Baltimore and Washington, where a distance of forty miles is daily covered in forty-five minutes, being an average rate of fifty-three and one-third miles per hour.

A speed equally wonderful, when the long distance travelled is considered, is being daily accomplished upon the Pennsylvania Railroad from New York to Chicago, a distance of nine hundred and twelve miles; the average running time made is a little over thirty-eight and one-half miles per hour.

From a table recently published we learn that the Pennsylvania Road runs trains from New York between Germantown Junction and Philadelphia eighty-four miles, at the average rate of forty-nine and four-tenths miles per hour. The fastest English trains for about the same distance (eighty miles) are run at the rate of forty-seven and one-eighth miles per hour. Upon the French roads, for runs of about the same distance, the fastest record is forty-four and one-third miles per hour.

By way of comparison of the early and present locomotives and speed of travel, the Baltimore and Ohio Railroad, over whose tracks we have been brought to this spot, will afford a good example.

The first locomotive built in this country to carry passengers was constructed by the late Peter Cooper, and commenced running in 1830. Its weight was less than one ton, drawing one car, containing thirty-six passengers, at the rate of thirteen miles per hour.

To-day trains pass over the road of the same company between Baltimore and Washington at the rate of fifty-three and one-third miles per hour.

The last and heaviest locomotive built has just been finished by the Baldwin Works, Philadelphia, weighs about sixty-four tons, has ten driving-wheels, and a capacity to draw 500 tons up a grade of 105 feet to the mile.

Cable roads for street traffic are increasing in number and are now in use in San Francisco, Chicago, Detroit, and Kansas City. Several lines are being constructed in Philadelphia: the general plan which originated in San Francisco in 1873, with modifications to suit the particular locality is the one usually adopted.

The elevated road just completed in Brooklyn is, I believe, the only one of that kind finished during the past year.

The cantilever principle for long-span railway bridges is much in favor.

It is believed that the first of any prominence built upon this arrangement was erected under the direction of one of our fellow members, over the Kentucky River, on the line of the Cincinnati and Southern Railway. This has a total length of 1,125 feet, and a clear span of 300 feet, and was finished in the year 1877.

The Niagara cantilever bridge was re-tested during the year and has shown remarkable immunity from changes, giving increased confidence in its stability and the correctness of the principles of its construction, which have been so fully elucidated in the interesting and valuable paper recently read before the society by our fellow-member Mr. C. C. Schneider.

The grandest work of this character is the bridge now building over the Frith of Forth.

The construction of a bridge of twenty-two spans two of which are of the enormous length in the clear of 1,700 feet each, is certainly a most formidable undertaking. The compression members of the span will consist of tubes, composed of steel plates, bent to form, and properly united by H-beams; they will vary in diameter from twelve to three feet. The tubular form, of course, presents no novelty of principle, it having been used in St. Louis and other structures but the size is unprecedented. The large piers consist of four cylinders each, of seventy feet diameter at the lower cutting-edges; they are sunk by the pneumatic system. Serious difficulties have not been encountered in sinking them to the depths of sixty-eight to eighty-eight feet. No new methods are employed, and none that were not successfully used at the St. Louis and East River bridges, and are at present followed at the new bridge building across the Susquehanna at Havre de Grace for the Baltimore and Ohio Railway, differing, perhaps, only in the details of air-locks, and means of removing the excavated earth, and supplying its place with concrete.

A cantilever bridge has also been completed across the St. John's River, to connect the Intercolonial railways with those of the United States. It has a clear span of 479 feet—nine feet more than that at Niagara Falls. This completes a link whereby the time between New York and Halifax can be shortened twenty-three hours, and will eventually be the means of reducing the trip from New York to Europe very materially.

The work of sinking the pier foundations for the bridge now building at Havre de Grace, for the new line of the Baltimore and Ohio Railroad is being prosecuted with much vigor, and presents examples of the most advanced practice in the pneumatic method of sinking caissons. This work is, as you are aware, being carried forward by members of our society.

The Tay bridge is now being rebuilt upon improved plans and on a new alignment. The resources now at the command of our bridge-builders, modern improvements in the manufacture of steel, with more reliable knowledge of its powers of endurance and resistance, make it possible to overcome difficulties that within a few years past would have been considered, if then proposed, as almost absurd.

It is scarcely necessary to point out how much has been done to increase the security of such structures, and modify their cost by the now very general use of improved testing machines, those belonging to the Government, and such as are owned by bridge manufacturers and others.

This society can look with satisfaction to its efforts in influencing and fostering the use of such means.

Next in order to the transport of railways over rivers comes to be mentioned the means of carrying them under the streams and through the mountains.

Of the former, the tunnel under the Mersey, between Liverpool and Birkenhead, has been carried to completion. Operations were begun in 1880. Four thousand two hundred feet of its length is under the bed of the river. It is through red sand-stone, and was driven by means of the Beaumont machine. There is a drainage tunnel under the bed of the road of seven feet diameter, and a similar passage of the like diameter near the top of the main tunnel for artificial ventilation.

A tunnel for the use of the Great Western Railway, of about four and a half miles long, was commenced under the Severn in 1873. Work was carried on with but little difficulty until the drift was within about 130 yards of meeting. A large influx of water took place in 1879, thereby delaying the work, now, however, approaching completion.

The channel tunnel, which has caused England so much uneasiness, has been driven on the British side for a distance of about one and a quarter miles, and on the French side almost half a mile. It is found by more than 2,000 soundings that gray chalk extends entirely across the channel. Work was done mostly by the Beaumont machine, and no very serious impediments have been met with. The water so far found is in pockets, and perfectly fresh. There is but little doubt that the tunnel could be completed for the amount estimated. Work upon it is now suspended.

The greatest achievement of modern mountain tunneling is the "Arlberg," reaching from Innspruck in the Tyrol to Lake Constance in Switzerland. Headings were commenced at both ends November 13, 1880, were pierced through November 19, 1883, and the whole completed September, 1884. Two methods of doing the work were adopted. Upon the Tyrol side Ferroux percussion air-drills were used, and on the Swiss side Brandt hydraulic boring machine. The distance accomplished by the air-drills was 14,874 feet, and by the hydraulic machine 17,351 feet. The rock, however, on the Tyrol side was harder, and presented more difficulties than upon the other end. The work was carried on with unexampled rapidity, showing remarkable progress in the methods employed.

The following comparison with the two mountain tunnels previously constructed will show the advance made in that class of work: "Mt. Cenis" tunnel, seven and four-tenths miles long, cost about $376 per foot run; "St. Gothard," nine and three-tenths miles long, cost about $238 per foot. The "Arlberg," six and two-tenths miles long, was completed for about $180 per lineal foot.

Hydraulic wedges, consisting of rams with cutting edges, have been used successfully to force down semi-detached masses of rocks in tunnels and coal mines, to a marked extent decreasing the use of explosives.

The Metropolitan District Railway of London has constructed a new section of four miles length, much of it under the most formidable difficulties, which may be judged of by the cost, which in some parts was $120 per lineal inch run,—$7,603,200.

Of the great canal projects, that of Count de Lesseps across the Isthmus has probably made as much progress during the year past as could have been expected with a work of such magnitude, and presenting so many obstructions.

The Suez Canal has almost reached its full capacity, and a large sum of money is about to be granted for enlargement.

Of the recently completed canals, the Maritime, from Cronstadt to St. Petersburg, is the most important. It is about seventeen and three-quarter miles long, and navigable for vessels drawing twenty feet. Work of excavation was mostly done by dredging machines, and has cost, including branches, over $8,350,000.

Excavation of a canal across the Isthmus of Corinth is progressing satisfactorily, and may probably be completed in another year. It is designed to be of the same width as the Suez Canal, is four miles long, and will reduce the length of voyage from the Adriatic to Turkey fully 185 miles.

Improvement of the navigation of our Western rivers by the use of movable dams has been tested fully in several cases. The Davis Island work is all completed, except the lock-gates, and machinery to work them. This, it is expected, will be finished during the year. It was, however, tested last summer by constructing a temporary coffer-dam across the head of the lock, which admitted a raise of the river sufficient to show doubters of its utility how great the advantages will be when completed.

Movable dams on the Great Kanawha River continue entirely successful, and have proved their usefulness on several occasions during the last year.

It is believed that probably the earliest application of movable dams for maintaining the water level of rivers was made by Mr. Josiah White, who patented the so-called "Bear-trap" dam an ingenious automatic device, and erected twelve such in 1819 upon the Upper Lehigh and its tributaries.

A similar dam to these is now proposed to be built on the Kentucky River at Beattyville. It is gratifying to find the words given below in the report of the United States Engineer for 1884:

"Jetties of the South Pass of the Mississippi have maintained the full depth and width of channels required by law during the year embraced by this report."

This is certainly a full and ample acknowledgment of the very valuable work accomplished by our fellow member, Captain Eads.

The stupendous project for building a ship railway across the Isthmus, proposed by this distinguished engineer, has been so fully explained and clearly described by the papers recently read before the society by Mr. Corthell, as to make any further mention unnecessary.

Methods of transporting earth when combined with water have been extensively employed under the charge of the United States Engineers at Oakland, opposite San Francisco. The sand under the surface is worked loose by a species of submerged ploughs fixed upon the lower end of a revolving tube, through which the sand and water are raised by a centrifugal pump and delivered through pipes to any point required. It is found, under favorable circumstances, as much as forty per cent. of solid matter can thus be delivered at a distance of 2,800 feet from the dredging machine. Sixty thousand cubic yards were delivered in this manner to a distance of 1,200 feet in one month, at a cost of from five to six cents per cubic yard.

The water-jet has been used in many cases during

the year in sinking piles and similar work. An experimental trial has been recently made to deepen parts of New York Harbor by means of an hydraulic injector-jet, with some prospect of success.

The most extensive and important work for the water-supply of a city is that upon the new aqueduct tunnel from the Croton Dam. Considerable work has been done upon the shafts and tunnel between the dam and High Bridge. It is a work of great magnitude and is being conducted with all the engineering ability that can be brought to bear upon it.

The next work of importance for similar purpose is the tunnel being constructed for the increased supply of Washington City. It will be about 20,750 feet long, through rock. Compressed air is used, not only for the drills, but for hoisting, pumping and ventilating. Air from the compressors is carried overground through five miles of pipe, which will finally be extended to ten. This tunnel was commenced November, 1884, and is expected to be finished during the present year. In connection with it the dam at Potomac Falls will be raised, and a distributing reservoir of large capacity be built.

The works for the supply of Baltimore, which some of you have had the opportunity of examining, have also a conduit in tunnel of seven miles in length; five years were occupied in its construction; it is twelve feet in diameter, and carries the water from the dam to the receiving reservoir. These works, with their white marble dams, large storage and distributing reservoirs, are now considered among the most complete and satisfactory in the country.

This may almost be said to be an age of tunneling. In this brief record we refer to three mountain tunnels, "Mt. Cenis," "St. Gothard," and "Ariberg;" three water-supply tunnels, Baltimore, Croton Aqueduct, and Washington City; three subaqueous tunnels, "Severn," "Mersey," and "British Channel."

It is scarcely necessary to say that the use of compressed air for power and ventilation, hydraulic machines, and high explosives, have made practical works of this character that would formerly have been impossible.

Thorough and extensive surveys are now being made by the Water Department of the city of Philadelphia, and gaugings an l rainfall data being obtained with the object of ascertaining the most feasible plan for increasing and improving the water-supply to the city.

The subject of maintaining the purity of the sources of water-supply is now demanding serious attention. There are many points not yet fully understood, or satisfactorily accounted for, notably the cause of water becoming foul in deep storage-reservoirs, as at Baltimore, Reading, and other places.

The analysis of water is still, to some extent, a doubtful process. A thoroughly reliable standard of absolute purity and wholesomeness has apparently not yet been agreed upon or made known by those engaged in investigation of the subject.

A method of oxidation of the impurities in water, by forcing air at high pressure through it in the ascending mains and reservoirs, has within the year been tried at the works from which Hoboken receives its supply; it is claimed to be successful. Apparatus is now being put into use for the same purpose at three of the pumping stations of the works at Philadelphia.

The advantages of aerating water by passing over dams and obstructions has long been acknowledged. Arrangements were introduced at Belmont Works, Philadelphia, in 1872, to expose the water discharged from the pumping main to the action of the air by passing it over three weirs and down the sloping banks of the reservoirs. If the same object can be accomplished, and more rapidly by the method above mentioned, it will be an important point gained.

Dr. Angus Smith experimented in 1882 on the effect of forcing air through sewage, and showed conclusively that "water saturated with air was no longer liable to putrefaction."

Knowledge of the amount of rainfall available from drainage areas has received much valuable addition from careful and extended observations of those engaged upon the surveys for the supply of New York, Boston, Philadelphia, and other large cities.

There is now in England a society called the "British Rainfall Association," the object being to put up as many proper rain-gauges as possible upon drainage areas, and elsewhere. It numbers over 2,000 intelligent observers.

The importance of such records can be fully appreciated by those of our members who have been called upon to study the important bearing of such determinations upon water-supply from gathering grounds, and the maintenance of the navigation of our rivers.

Public supply of hydraulic power has been in use in Hull, England, since July, 1882. The system is now being introduced into London. Mains for the purpose are laid upon both sides of the Thames, from Blackfriars to London Bridge. These are kept supplied by triple-cylinder compound pumping-engines, through an accumulator, under pressure of fully 700 pounds to the square inch.

Power thus produced is utilized on both banks of the river by cranes, elevators, and driving machinery. One of the most useful of its functions is an ingenious arrangement for increasing the efficiency of water-supply during fires. By means of a so-called "injector-hydrant," water taken from the ordinary supply-mains at a pressure of about thirty pounds to the square inch can be made to deliver 150 gallons per minute through 1-inch nozzle to a height of over 80 feet, with a consumption of about 24 gallons from the main under high pressure.

The advantage of such a system, available at a moment's notice, upon the docks, and in neighborhoods where valuable storehouses are situated, can readily be seen.

Compressed air has also been supplied to the public in several cities of Europe, applied to production of power for small machines, the transportation of parcels through business establishments, and for postal and telegraphic purposes, by a somewhat similar arrangement to that which has been some time in use by the Western Union Telegraph Company in New York.

One of the most important developments of the year is the utilization of natural gas for fuel in manufactures and for domestic use. By its employment it has been found that a cleaner and better grade of iron and steel made by the Siemen's open-hearth method has been produced than by the use of coal.

A novel use of compressed carbonic acid gas was made at the Krupp Works. Gas is admitted under very high pressure over the steel in molds during its solidification, thus securing perfect castings.

This gas is now supplied commercially in Germany compressed to a liquid state in iron bottles. In Berlin it is now used by the steam fire-engines as motive power, enabling them to do service before getting up steam.

Much attention has been paid to sanitary engineering, but the best system of disposing of sewage and the merits of separate or combined systems of sewers are still mooted questions. The latter can probably be best decided by the topography and local conditions of the place to be drained.

An exceedingly ingenious method of sinking shafts through quicksand employed in Europe deserves mention. The whole mass surrounding the shaft was frozen solid by sinking pipes around its sides by means of sand-pumps; into this was forced a freezing mixture. By this means a space 24×27×18 feet deep was frozen in thirty days, the shaft sunk and walled up without damage or danger to those employed.

In telegraphy, the Delaney multiplex method of passing as many as seventy-two messages over one wire has been developed in the year, and is in practical use between Boston and Providence.

The Phelps system, whereby messages may be transmitted to and from rapidly moving trains, bids fair to be one of the most important and useful applications of telegraphy invented.

The electrical exhibition held in Philadelphia last year afforded an excellent opportunity to study the rapid strides being made in that branch of engineering. Exhaustive tests have been and are still making by the Institute upon the duration of incandescent lights, and to determine the economy and efficiency of the dynamos and kindred apparatus submitted for the purpose.

I think we may look forward to the use of electricity as motive power on our railroad trains, probably applied to every pair of wheels upon the entire train, thus dispensing with the excessively heavy locomotives of the day, to the great advantage and reduced cost of the bridges and roadbed.

Considerable improvement has been made in the duty performed by water-works pumping-engines, much rivalry being exhibited by several builders.

Compound engines have in all cases been adopted mostly with horizontal steam and pump cylinders.

The time-honored Cornish pumping-engine is now almost entirely abandoned, even in conservative England.

Duties ranging from 84,000,000 to 105,000,000 foot pounds with 100 pounds of coal have been claimed upon trial tests.

Some of the most powerful and successful pumping-engines are those employed upon "oil-pipe lines." They are of the Worthington compound duplex type; the work performed is exceedingly severe, the requirements in many cases being the delivery of 15,000 barrels of crude oil per day, frequently under a pressure equal to a head of 3,500 feet the engines being required to run day and night throughout the year. Engines of this class were ordered from and sent to England by Mr. Worthington, for the purpose of forcing water through a pipe-line across the desert, but the withdrawal of the army from Egypt made them unnecessary.

I cannot close without congratulating the society upon its progress, increasing prominence and usefulness.

The accession of members in the past year has been greater than in any other since its formation.

The high standard of requirements necessary for admission to membership has in no way been relaxed, and it is hoped will be rigidly maintained.

The reports of committees upon "Uniform Tests of Cement," "Uniform Standard Time," "Preservation of Timber," and many other subjects, have exhibited much labor and research, and must undoubtedly prove of great advantage.

May we not, from the experience of the past, anticipate a prosperous future for the American Society of Civil Engineers?

WATER.

THE Morgan Water Supply Company has filed a certificate at Denver, Col., that its capital stock of $100,000 is fully paid up.

IN an article on "Hydraulic Lime" published in this journal last week, the famous lime of Teil is particularly mentioned. It is also referred to in the valuable paper on Cement tests in this week's paper. We understand that James Brand, of 85 Beekmen St. is the *only* importer of this very celebrated brand of cement.

ASPEN, Colorado, June 21.—At the meeting of the Council last night it was decided to award the water works franchise to Messrs Simmons & Abendroth of New York and St. Louis. The privilege is to run twenty years and the contractors are limited to four months' time in which they must have the works in operation. The service will have 350 feet of head, and fifty hydrants will be served through four miles of pipe. A special election was held June 27, at which the voters would ratify or reject this agreement.

THE City Council of Menomonie Dunn. Co. Wis., Monday, June 23, 1885, passed an ordinance granting to Hinds & Moffet, of Watertown, N. Y. and Phelps & Ferris of Minneapolis, a franchise to build water-works to supply that city with water for thirty years. The plans by E. G. Ferris contemplates taking water from Red Cedar River into a filtering well in sand rock, pumping through a two-inch main to a tank 80 feet high on a hill about 90 feet above the Court House Square, or something more than 100 feet above the main business position of the town, or about 80 pounds pressure on most of the hydrants. There will be five and one half miles pipe 10 to 4-inches, 80 hydrants at an annual rental of $50 each. Works to be completed in December 1885.

ENGLISH LOCAL INDEBTEDNESS.—From a recent parliamentary document it appears that the local indebtedness of England is increasing at a rapid rate. A gain of 71 per cent. in eight years is certainly remarkable. During the same period the national debt decreased, and a comparison of the two for the years 1875 and 1883 shows the following variations:

	1875	1883
National (United Kingdom)	£772,000,000	£756,000,000
Local (England and Wales)	93,000,000	159,000,000

The chief portion of the local indebtedness has been incurred for sanitary purposes, which illustrates how prominently this administrative department is demanding consideration. One-fifth of the outstanding loans of municipalities should be placed to the metropolis; and it should be added that an average annual amount of £4,672,000, or 36 per cent., has been raised by the local governments as an offset to this indebtedness.—*Bradstreet.*

AT Toronto, Canada, it has been found that when the water-works engines shut down there is a noticeable decline in the pressure all over the city. In some cases hydraulic hoists refuse to work, and on the whole the condition of affairs is unsatisfactory. An investigation of this matter leads to the belief, amounting to a certainty, that the reason of this low pressure is the insufficient capacity of the great distributing pipes. Various methods are mentioned of correcting this state of affairs. The Mayor proposes that stop-cocks be put on the pipes leading east and west, and that in case pressure should be especially required in the east or west, the water could be stopped on one division and the whole pressure applied to the other. This is only a temporary measure however. The construction of another reservoir on Wells' hill will have his hearty support. The prospects in the water department, are bright. In the immediate future the citizens will be getting absolutely pure water, the expenses of pumping are being reduced by wise management and the revenue of the works is going up rapidly and steadily

ON Tuesday June 24th, the following bids were received and opened by the Trustees of Water-works of Lima, Ohio:

	Reservoir complete.
Adam Parker, High Bridge, New York	$80.565
T. M. Hussey, Sidney, O.	61.066
W. T. G. Snyder, Bellefontain, O.	92.651
C'Connell & Murphy, Youngstown, O.	29,259
T. B. Douglass & Co., Dayton, O.	44.430
Water and Gas Works Construction Co., Pittsburg, Pa.	48.267
D. F. Minehan, Springfield, O.	41.519

The bids on Building for Pumping Station and Stacks were as follows:

D. F. Minehan, Springfield, O.	$9.649
James McKinney, Lima, O.	8.720
Shuler & Mowen, "	8.581
L. B. Stevens, Toledo, O.	7.775
W. H. Campsfield, Lima, O.	9.000
Graham & Seargent, Toledo, O.	7.880
A. C. Baxter & Co., Lima, O. Plumbing & Heating.	$575
John Hutton, Lima, O. Galvanized Iron & Slate	723

Contracts not awarded on the 27th.

H. N. P. Dale of Columbus, Ohio, has the contract of Pipe laying and has been carrying on the work with considerable energy, but on the 26th the hands struck for $1,50; they have been receiving $1.25 per day. Mr. Dole says he will not yield to their demand. Some are willing to work at $1.25 but strikers will not permit it.

NEWS OF THE WEEK.

Railroads, Bridges and Canals.

Mexico R. Rds.—Americans have $125,000,000 invested in Mexican railways.

Florida R. R.—A large construction force will be put on the southern extension of the Florida Railway and Navigation Road by July 4.

The Fargo Southern Railroad will this summer be extended south to Flandreau, Minn., at a cost of about $1,000,000.

C. R. I. and St. J. R. R.—It is now settled beyond doubt that the Chicago, Rock Island and Pacific Road will extend its line to St. Joseph.

Union Point and White Plains Road.—Mr. Hutchins, civil engineer from Athens, Ga., began a survey of the proposed railway from Union Point to White Plains on the 24th ult.

Mankato advices say work is to be commenced on the Cannon Valley road July 1, and the line pushed to that city at once. The engineers of the road were in Mankato June 20.

Japan Railroads.—The railroad system of Japan has attained a length of 225 miles, and is increasing steadily. It has been mainly built by the Japanese government with native capital. The business results up to the present time have given no cause for dissatisfaction.

Connotton Valley Reorganized.—A meeting of the security holders of Connotton Valley R. R. was held in Cleveland on June 24th. The name of the line was changed to the Cleveland & Canton. The road is to be made of standard gauge and extended to Zanesville.

Crookston, Minneapolis & Duluth is the latest Dakota railroad organization. It was organized at Crookston. The officers are: T. B. Walker, president; J. Comb, vice president; W. D. Hurlburt, secretary; and A. Bates, treasurer.

Black Hills R. R.—Contracts have been let for grading the entire route of the Black Hills branch of the Northwestern road from Chadron, Nebraska, to Rapid City. The work is to be completed by the 15th of July, 1886. A corps of engineers are now surveying the Black Hills end of the line.

The Republic of Chile now owes on account of her railways $22,470,000. In 1883 these railways earned a revenue of $5,519,049, on a capital of originally less than $60,000,000, and which is now reduced to $22,450,000. Good management and liberality on the part of the Government have brought about this splendid financial result.

The Union Passenger Railway and Transfer Company was incorporated at Albany, N. Y., on the 22d ult. It has a capital of $11,000,000 and tracks forty miles long on almost all unused streets. The directors for the first year are W. L. Elkins and W. H. Kemble of Philadelphia and Henry Thompson, George Terry, John F. Schooley, William Parr and Edward Selleck of New York.

The Railways of New South Wales, though essentially one entire concern, as the property of the Government, are at present separated into two great divisions, viz., the Southern and Western Railway and the Northern Railway—the one having its principal terminus at Sydney, the other at Newcastle, upwards of sixty miles apart. The line from Sydney to Parramatta was opened for traffic on 26th September, 1855.

Toledo, Columbus & Southern.—The work of grading for the extension of the Toledo, Columbus & Southern Railway was commenced at Findlay, O., June 25th, and the road will be pushed through to the Ohio River as rapidly as possible. The Company expect to complete their bridge at Findlay and complete their connection with the Indiana, Bloomington & Western road within thirty days. The new terminal facilities at Findlay, are to cost $50,000.

Glenn Mary to Carthage. Major Blanchard and his field corps have finished the survey of the proposed line from Glenn Mary on the Cincinnati Southern R. R. to Carthage, Tenn., as far as Cookeville. While the road will necessarily be an expensive one to build, it is nevertheless practicable, which was thought doubtful at first. The heaviest grade on the line from Glenn Mary to Carthage, Tenn., is 130 feet to the mile, at a point on the line known as the Buck Mountain, three miles east of Cookeville.

The Smallest Locomotive in the United States.—The Central wharf railroad shops, Pensacola, Florida, have recently made the smallest locomotive ever built in the United States for regular service. The engine is for a 20-inch gauge road. The cylinders are 5 by 8 inches; driving-wheels 12 inches in diameter: 4¾ feet is the greatest height above the rail, and it has 97 tubes 1¼ inch in diameter. The tank holds 180 gallons of water, and the coal-bunkers have a capacity of 250 pounds. The whole machine is only 9½ feet long, 7½ feet wide, and weighs in working order, 3¾ tons. She has attained a high rate of speed. She pulls 15 loaded cars, weighing about 45 tons, and handles them easily. A pressure of 80 pounds is carried.

Painsville and Youngstown.—It is said that within a month, a syndicate, headed by Solon Humphreys, will possess the Painesville and Youngstown Railroad, running sixty miles from Youngstown, O., to Painesville, on Lake Erie. The road will be widened to standard gauge and leased to the Pittsburg and Western. This would form the shortest route via Youngstown between Pittsburg and Lake Erie, and would give the Baltimore and Ohio, which is the lessee of the Pittsburg and Western, an excellent outlet on Lake Erie.

The Cincinnati, Hamilton & Dayton main line, extending from Cincinnati to Toledo, is a road with the the lightest grades of any road in the country for so great a distance! A first-class consolidation engine will haul seventy loaded cars from Toledo to Cincinnati and sixty-five from Cincinnati to Toledo. Recently one of these engines hauled 116 loaded cars on the D. & M. from Lima to Toledo, and the same engine returning hauled eighty-five loaded cars from Toledo to Lima. On the south end of the road it is not an unusual thing for an ordinary freight engine to haul seventy-five cars from Dayton to Cincinnati, and going northward between those points seventy loaded cars.

The Toledo, Ann Arbor and North Michigan Railway Company has executed a contract with a wealthy syndicate in New York to acquire and construct 42 miles of track from South Lyons to Owosso, Mich., thereby connecting its Northern and Southern Divisions. According to the contract the work must be done by Nov. 1. This will make a continuous line from Toledo to St. Louis. The same syndicate have also contracted to extend the Toledo, Ann Arbor and North Michigan Railway northerly from its present terminus at St. Louis into the pineries, and open it to Mount Pleasant, Mich., also by Nov. 1. We do not know the "wealthy syndicate" but headquarters of the railway will probably be at Toledo, and Chas. E. Greene of Ann Arbor is the Chief Engineer of the Company.

Discharging its Officers.—The Southern Pacific Railway Company has found it necessary to further reduce its operating expenses. It is stated that since the beginning of the present year 2,500 employes have been asked to resign. The company has now decided to abolish several departments and to dispose with a number of prominent officials, who have been connected with the road since its first days. Among those who will resign July 1st, are: W. H. Porter, general auditor; Edwin M. Railton, master of transportation; O. C. Wheeler, general baggage agent; William Hood, chief engineer of the Central Pacific; George E. Gray, chief engineer of the Southern Pacific, and others less prominent. The explanation of it is that business of all kinds has fallen off. The actual traffic of five months this year is far below the estimates, and it is affirmed that the operating expenses have been in excess of the receipts.

Canadian Pacific.—There are about 120 miles of the Canadian Pacific yet to be completed, seventeen miles west of the second crossing of the Columbia River and 103 miles east of the crossing. There is one stretch of thirty miles on which not a tree has been cut nor any other work performed. The remaining ninety miles about half-way graded. It is the opinion that the road can not possibly be finished before the first of next January, notwithstanding the published statement that the line will be opened for traffic September 1st. Muir Brothers, who have the contract for building a tunnel 750 feet long, about thirty miles east of the second crossing, have not got to work yet, though they expect to commence operations very soon. They say they cannot complete the perforation in less than four months. They have the contract also for another tunnel about 350 feet long. About 3,000 white men are employed on the work, and the company want 6,000 more right away. The pay is $2 a day. And the men may work a day and a quarter every twenty-four hours if they choose, of course getting additional pay for additional work.

A New Railroad Short Line.—A new railroad is proposed, and it is urged in its behalf that "it will create a line shorter by 100 miles than any other now in existence from an interior city to the seaboard." The name and locality of this enterprise are not mentioned, because it is not the purpose to disparage the enterprise in the minds of any who may be disposed to put money into it. Separately considered it may have ample merit. But the broader question arises whether additional lines are anywhere needed from the interior city to the seaboard. More lines already exist than the traffic can possibly support, and some of them are bankrupt even now, while others have continued the payment of dividends by increasing their debts. The building of a new line will no doubt be beneficial to some people; it will help the trade of some localities, but mainly by diverting trade from other places; it will give new opportunity for some people to place securities upon the market and to make money by manipulation, and it will offer fine chances for administrative skill in construction rings and in the assignment of contracts. But it may be doubted whether there is any part of the country in which a new road from the interior to the seaboard can be said to be justified by the present volume of traffic or the present prospects of business.—*New York Tribune.*

Canadian Pacific.—A returned traveler says that one hundred and twenty miles of the Canadian Pacific remain to be built. There is one stretch of thirty miles on which not a tree has been cut. The contractors for a tunnel 750 feet long have not yet begun boring, and they say it will take them four months. They have contracted to make another tunnel 350 feet long. About three thousand white men are now employed on the work. The gentleman says that "rugged" is no name for the Selkirk range. The wildest places in the Cascade range known to human feet are meadows compared with these wilds of rock and timber. One avalanche of snow swept down last winter on the line of the proposed road, the like of which is unknown to this latitude. It was three miles long and 500 feet deep, and mowed down acres on acres of largest trees as if they were pipe-stems. The snow lies yet to the depth of forty feet and trains and horses travel over it daily. On the Illiasillooet River, along which the railroad runs for a considerable distance, there was a snow slide which completely dammed the river, and it took sometime for the water to cut a channel through it. At this time the river may be seen flowing through banks of snow 100 feet high.

Paying Railroad Employes Under Difficulties.—The following is a part of a report from the cashier of the South Indian railway to the chief auditor:

Most Honored Sir—In continuation of my telegram of the 13th inst., I beg leave to bring to your notice that I had a narrow escape from the attack of a leopard by your favor and by the grace of the Almighty. A certain leopard—I think a stray one—appeared all on a sudden, to our heartrending fear, while payment was being made in the 93.9 mile on the line. The coolies numbered about 400. All of us were engaged. The coolies one after another, crying: "Tiger! tiger!" took to their heels; while I, fortunately, found a picottae standing near a ditch and got up to the top of it to save my life at any risk. Fortunately for me, Mr. Lloyd, the assistant engineer, on hearing this, came to the spot. Mr. Lloyd tried a shot but missed the aim. In the meantime, as a godsend, a light engine happened to run there. The engineer, detaining the engine, got into the tender and began to shoot therefrom. Aims several times failing, the leopard sprang up. In this state of things my body shook with fear as I was witnessing the trials as well as the fierce action of the leopard. Mr. Lloyd had the presence of mind to shoot it undaunted until it was killed, then I took heart and came down to commence payment.

The Cincinnati Northern Railroad, extending from Cincinnati to Waynesville, O., was sold June 27, by order of the United States Court to A. S. Winslow for $200,000. Mr. Winslow represents the first mortgage bondholders. The road has a mileage of about thirty-six miles of three feet gauge, and is about the poorest narrow gauge plant in America, besides being the best watered concern in the world. The road was originally called the Miami Valley Narrow Gauge Railway, and was sold under foreclosure in 1880. The purchasers reorganized the Company and issued $1,000,000 of stock: $1,000,000 of first and $1,000,000 of second or income bonds making the stock and bond debt $3,000,000 on a road that cost less than $3,000,000. The road enters its Cincinnati station on a down grade of 185 feet to the mile. The physical condition of the line has always been exceedingly bad. About two years ago the Vice President and the Cincinnati end of the Directory started to Toledo over the line, which connected with the Dayton Division of the Toledo, Cincinnati and St. Louis Roads at Dodge, O. The party had not proceeded many miles before they had to get out and "walk around some dangerous place." After they got "around" they concluded the safer way would be to take a hand-car and work their passage, which they did, risking, for a few miles at a time, one of the occasional trains. In this way, at the end of the second day out, they reached Toledo. It is needless to say they came home via the C. H. and D. The road was in better condition than at any time since. It would appear, therefore, that Mr. Winslow paid about all the property is worth.—*St. Louis Globe Democrat.*

Miscellaneous.

Contracts for building.—T. H. Brown & Co., contractors and bridge builders, have taken the contract to build all the trestle bridges, do all the pile driving and put in log walls, etc., on the Jacksonville, Tampa and Key West Railroad between Buffalo Bluff and Sandford and will begin work immediately.

The Kerr System of Pavement.—The Kerr system of pavement, which was first introduced into the United States in 1884, is meeting with recognition in this country. A test of it is about to be made in St. Paul. The estimate for four blocks is $14,525. It was originally introduced into London in 1877, and four years later it made its way into Paris.

British Iron and Steel Exports.—The total quantity of iron and steel exported in May was 275,639 tons, a falling off of 91,333 tons from the shipments of May, 1884, or a decrease of nearly 25 per cent. In March the decline was 9.1 per cent., and in April 13.5 per cent. A

statement of the exports of iron and steel to the United States during the month of May, 1884 and 1885, shows the following:

	Tons. 1884.	Tons. 1885.
Pig Iron	16,451	9,734
Bars, angles, etc	413	270
Cast and wrought manufactures	534	127
Old iron	3,471	104
Railway material	51	1,842
Hoops, sheets, etc	777	861
Tin plates	23,154	23,685
Steel, unwrought	1,140	1,256
Total		37,389

It will be noticed that tin plates alone constitute 61 per cent. of this total. Shipments of pig iron to continental countries fell off largely, Russia being a notable example. France and British North America were the only customers which called for an increase. A comparative statement of the exports during the first five months of the last twelve years show that no year since 1879 presents an amount as low as 1885.

The value of through sanitation if fully appreciated by the inhabitants of the watering places along the Western Coast of England. All the world has heard of the complete sanitary system in vogue at Torquay—one of the most lovely resorts to be found anywhere in the world—where no expenditure is spared to keep the town and its environs in the most scrupulous conditions of cleanliness and health. The people of Torquay have spent, roughly speaking, some £100,000 upon their water supply, and nearly the same amount in carrying out one of the most perfect systems of main-drainage in England. The water-supply of the town is collected in Dartmoor, 14 miles distant, and conveyed to Torquay in iron mains from a vast reservoir capable of holding 200,000,000 gallons. The supply is constant, and its purity is the highest of any water in the United Kingdom, with the exception of that of Loch Katrine. Soon after the first iron main was laid from Dartmoor, some difficulty was experienced in cleansing it from vegetable matter, etc., which in the course of time accumulated. This difficulty was, however, solved by the invention and adoption of a cleverly-constructed revolving scraper, which was inserted into the main at the higher end and driven by the pressure of water the whole distance of 14 miles into Torquay. The pressure of the water causes the scraper to rotate with great speed and force, and the main is opened at certain points to allow the matter released by the scraper to escape. The scraping process is gone through about once a year in each of the two mains.—*Sanitary World.*

Index to Periodical Literature.

Blasting.—*See* **Submarine Blasting.**

Boilers.—*Modern Practice in the Construction of Steam Boilers.* A carefully prepared paper by D. S. Smart. It deals with the materials used, the joints and seams, staying of boilers and flues, and remarks on various ordinary and special types of boilers. It enters fully into detail. A discussion is appended, containing much information as to actual practice, tests and causes of accidents. Several illustrations and tables are given. *Minn. Proc. Inst. Civ. Engs.*, vol. lxxx—Session 1884—1885—part 2.

Building Stone.—*The Building Stones of Minnesota.* This paper describes the geological formation of the State; the western portion being destitute of building stone while the eastern has several varieties. It is richest in limestones, has large quantities of granite, and some amount of sandstone. The various classes of each are mentioned, with notes as to their use, location, cost, etc. A table of their strength is given. W. A. Truesdell. *Journal of the Assoc. of Eng. Societies*, June, 1885. pp. 302 to 314.

Car Starters.—A paper by J. B. Johnson, read before the Engineering Club of St. Louis, March 18, 1885. It likens this advice to the perpetual motion, showing by mathematical calculation that no invention relying on springs can ever be a success, since a spring capable of performing the work would weigh 3,403 pounds, and be 15 feet long; while the largest spring that could be practically used would only store 15 per cent. of the energy. The author thinks a little better of compressed air, but doubts if even that would be of practical value. *Journal of the Assoc. of Eng. Societies*, June 1885. pp. 293 to 302.

Car Truck.—*See* **Rolling Stock.**

Dredging.—*Cost of Dredging at Calais and Boulogne.*—For sand, steam hopper-dredges fitted with sand pumps are employed, cost about 14¼ cents per cubic yard, contract to be renewed for 9¼ to 13 cents, according to conditions. For other material bucket dredges are used; cost for ordinary material 24½ cents measured in the barge; for hard soil 63 cents per cubic yard. Report of M. Guillain, engineer-in-chief. *Translated for Inst. of Civ. Engs. Min. of Proc.* vol. lxxx, session 1884—1885, part 2.

Electricity.—*Secondary Batteries.*—Gives the history of the accumulator from its earliest inception in 1801 to the latest inventions of Faure and Planté; and describes the various successive inventions and improvements. Remarks are made on the practical uses to which they have been applied. *Min. Proc. Inst. Civ. Engs.*, vol. lxxx, session 1884—85, part 2.

Friction.—*Experiments on the Friction of Disks Rotated in Fluid.*—Describes the apparatus and methods of experimenting, and gives numerous formulæ. Tables and diagrams of results are given, and a sketch of the apparatus. By W. C. Unwin. *Min. Proc. Inst. Civ. Engs.*, vol. lxxx, session 1884—85, part 2.

Measures.—*A Comparison of British and Metric Measures for Engineering Purposes.*—Decidedly in favor of the metric system as being more convenient, rapid and accurate than the British, and points out the disuniformity of the latter, as land, earthwork, brickwork, lime, water, etc., all have a different measurement. A lengthy discussion is appended, and a map showing the large proportion of European countries using metric measures. By Mr. Hamilton-Smythe, M. I. C. E. *Min. of Proc. Inst. of Civ. Engs.*, vol. lxxx, session 1884—85, part 2.

Rolling Stock.—*Standard Freight Car Truck.*—A brief description, with detail drawings, of the type proposed by the Master Car Builders Assoc. It has a diamond frame, helical springs, and inside brakes. *Railroad Gazette.* June 26, 1885, pp. 401, 405.

Secondary Batteries. (See Electricity).

Steel. *Steel for Shipbuilding.*—A paper on the nature and strength of the material, with notes of results of experiments. The injury from careless heating when it has to be curved or bent, and from punching is pointed out. Steel rivets may be used. Specifications for tests are given, with sketches of the results to iron and steel plates from the falling weight test. *Inland Marine.* June 20, 1885.

Thermodynamics.—*Guns Considered as Thermodynamic Machines.*—A mathematical consideration of the amount of heat generated by the explosion, and the way in which it is absorbed; with the results to the gun and projectile. *Min. Proc. Inst. Civ. Eng's.* vol lxxx, Session 1884-85, part 2.

Water.—*Gauging Flowing Waters.*—A paper describing the methods of "notch-gauging," with formulas, diagrams, and tables of results. The operation of gauging the flow of the River Severn, in Wales, in 1880 is briefly described. *Min. of Proc. Inst. Civ. Engs.* vol. lxxx, Session 1884-85, part 2.

Water-meters.—An exhaustive paper by Ross C. Browne on comparative tests of accuracy, delivery, etc. It deals with two principal piston meters—the Worthington and Kennedy,—and three forms of velocity meters—the German and English types of Siemens, and the Hesse. The Worthington is stated to be liable to deterioration of sensitiveness, the Kennedy heaviest and most expensive, and the Siemens inferior in sensitiveness, while the Hesse is considered to combine the main good points of the others with an advantage as to sensitiveness, price and wear. The meters are illustrated, and several diagrams and tables of results given. From Trans of Tech. Soc. of the Pac. Coast.

Market Report of Engineering Materials.

New York, July 2, 1885.

NOTE.—The following Market Report gives wholesale prices on the New York Market unless otherwise stated. It is intended as a general guide to the estimating engineer, and both the range of material and the market location will be extended as rapidly as possible. We give it with this caution, that, as is well understood in business transactions, the amount of bill, distance from market centre and conditions of payment will have a material influence on the final paying prices.

IRON.

STRUCTURAL IRON.		
Angles	1.9c.	@ 2.2c.
Tee	2.2	@ 2.25c.
Beams and channels	3.0c.	@
Tank	1.9c.	@ 2. 0c
Shell	2½c.	@ 2¾c
Steel plates, Tank	2¾c.	@ 3c.
WROUGHT-IRON PIPE., PITTSBURGH.		
Butt welded, black ..Discount	45	@ 50
" " galvanized "	35	@ 40
Lap welded black "	65c.	@
" Galvanized "	45	@ 50
Boiler tubes "	60	
RAILS.		
Steel (large lots at mill)	$27.00	@ 27.50
Old rails	16.50	@ 17.00
Old rail steel	16.50	@ 17.00
R. R. spikes	1.8	@ 1.9c
R. R. splice-plates	1.65c.	@ 1.75c.
R. R. Track Bolts	2.6c.	@ 3c.
Barb-wire fencing, galvanized	4½c.	@ 5½c.
" painted	3½c.	@ 4½c.
Corrugated iron		
Nails		
Iron	2.25	
Steel	2.25	

METALS.

COPPER.		
Lake Superior	11.35	@ 11.40
Other Brands	10¾	@ 11½
LEAD.		
Com. Domestic	3.65	@ 3.70
Lead Pipe	.05¾	
Tin-Lined Lead Pipe	.15	
Sheet Lead	.06¾	
ZINC.		
Sheet	0.05	@ 0.05½

BRICK.

(Cargoes afloat)		
Haverstraw per M.	$6.25	@ 6.50
Fishkill	4.75	@ 5.50
Up-River	5.70	@ 6.00
Jerseys	5.50	@ 5.75
Long Island		
" pale		
FRONTS.		
Croton red	13.00	@ 14.00
" dark	13.00	@ 14.00
" brown	12.00	@ 13.00
Philadelphia pressed	24.00	@ 25.00
Trenton "	24.00	@ 25.00
Baltimore "	37.00	@ 41.00
Buff "	33.00	@ 35.00
Enameled English	65.00	@ 130.00
" American	85.00	@ 120.00
Fire brick	25.00	@ 40.00

CEMENT.

PORTLAND.		
Gibb's English 400 lbs. per bbl	2.75	@ 2.90
K. B. & S. " "	2.85	@ 3.00
Burham " "	2.70	@ 2.85
Keene's fine " "	9.50	@ 10.00
" course " "	5.00	@ 6.00
Roman	2.75	@ 3.50
Largerdorfer German "	2.55	@ 2 80
Dyckerhoff, " "	2.90	@ 3.25
Stettiner " "	2.60	@ 2.65
Hanover " "	2.60	@ 2.65
Vorwohler, Lion "	2.90	@ 3.25
Alsen, " "	2.55	@ 2.60
Fieve " "	2.40	@ 2.50
Saylor's American	2.15	@ 2.40
Windsor	1.00	@ 1.1
Standard U. S. C. Co.		1.15
Cable's Portland	2.15	@ 2.40
ROSENDALE cements	1.00	@ 1.10

LIME.

Rockland common per bbl	1.00
" finishing	1.20
State, common	.90
" finishing	1.10
Kingston, ground	0.95
Add 25c. to above figures for yard rates.	

STONE.

Cargo rates at New York.

Amherst freestone, No. 1 per cub. ft.	0.90	@ 95
" " No. 2 "	0.75	@ 0.80
" " light drab "	0.80	@ 0.95
Berlin " in rough "	0.75	@ 1.00
Berea " "	0.75	@ 1.00
Brownstone, Portland, Ct. "	1.00	@ 1.30
" Belleville, N. J. "	0.75	@ 1.25
Granite, rough	0.60	@ 1.25
Common building stone per load	2.00	@ 3.00
Base stone, from 2½ to 6 ft. lengths, per lin. ft.	0.40	@ 3.00

SLATE.

Purple roofing per square	6.00	@ 7.00
Green "	6.00	@ 7.00
Red "	15.00	
Black Penna. (at New York) "	4.50	@ 5.00

LUMBER.

Prices for yard delivery in New York.

PINE, Common box per M.	16.00	@ 20.0
" Choice "	55.00	@ 80.
Tally plank, 1¼ in. 10 in. dres'd, each.	.44	@ .5
Tally boards, dressed com. "	.28	@ .30
SPRUCE, Boards dressed "	.25	@ .28
Plank, 1¼ in "	.28	@ .30
" 2 in. "	.38	@ .40
" 2 in. dressed "	.43	@ .45
Timber per M.	20.00	@ 22.00
HEMLOCK, Boards each.	.18	@ .20
Joist, 2½ × 4 to 4 × in	.17	@ .44
OAK per M.	55.00	@ 65.00
CYPRESS 1, 1½, 2 and 2½ in "	35.00	@ 40.00
YELLOW PINE, Girders "	26.00	@ 35.00
Dressed flooring "	30.00	@ 40.00
SHINGLES, Extra shaved pine, 16in. "		
" sawed 18 in. "	5.75	@ 6.00
LATH, Cargo rate "	2.40	@ 2.50

PAINT.

Lead, white, American dry per lb	.04¾	@ .05
" " in oil pure "	.05½	@ .05¾
English, B. B. in oil	.08¾	@ .08¾
Red, American	.05½	@ .05¾
Litharge "	.05	@ .05¼
Venetian red, American "	.01	@ .01¼
Indian red "	.05	@ .10
Vermillion, American lead "	.11	@ .11¼
Paris green "	.15	@ .19
Umber, Amer. raw and powdered per lb.	.01¼	@ .01¾
Drop black, Amer.	.08	@ .12
" "	.09	@ .11¼
Chrome green	.05	@ .15
Oxide zinc, American	.03¼	@ .04
" French	.06¼	@ .06¾

Tests of Building Stone.—At the Denver & Rio Grande Railway shops State Engineer Nettleton has made a crushing test of the various samples of building stone submitted by quarry owners all over the country to the State Board of Capital Managers. The test showed that for strength the best stone came from Colorado quarries, and some of the samples which are two inches square required a pressure of 60,000 pounds to crush them.